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OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS ... 223

The Record Broken. THE great and self-made enemy of alternating currents has just been granted a patent for an alternating current generator. Workers in this field need not be alarmed, however, it is not a fundamental patent, nor is it one covering a term of 20 to 25 years as in some other cases, instead of the legal term of 17 years.

Graphical Tables. A DIAGRAM published in this issue, when compared with a set of tables for the same purposes published some time ago, will show the great advantage of graphical methods over the older and more cumbersome numerical tables. We call attention to it here because the same principle may be applied to many other electrical tables involving similar calculations. There exists unfortunately an unwarranted prejudice against graphical calculations, due doubtless to the fact that many persons, who are not used to such methods, consider them too deep and mathematical. In point of fact, however, it is quite the contrary. To use such methods is easier than multiplication and division, besides which one is sure of the result (provided the curves are correct), while in arithmetical calculations errors are so apt to creep in that it is necessary to repeat the calculation as a check on the work. A little less prejudice against graphical calculations cannot fail to result favorably for those who have many calculations to make.

No Grounds to be Allowed Hereafter. IT has been the custom in installations using the three-wire system underground to ground the neutral wire. In Europe the same thing is done by using the lead coverings of double cables as the neutral conductor. The origin of the practice in this country appears to have been that occasionally one of the three wires becomes grounded, and in order not to be compelled to stop, this wire was simply made the neutral conductor, resulting now in a regular grounded system. The New York Board of Fire Underwriters has now condemned this practice as dangerous and orders it to be stopped. A grounded system means that an accidental ground at any *one* other point will and must cause trouble of some kind, or, in other words, it makes live wires of gas and water pipes. It furthermore interferes with the proper testing of all the lines. There can be no doubt that the practice of grounding the neutral is not as safe as a completely insulated system. To change it now, however, may require much work, and therefore may interfere somewhat with the lighting. It is a case in which prevention would have been better than cure. The Edison company, of New York, which is affected by this resolution, appears to consider it a "trifling matter" and is willing to make the change. Others, however, ought to take heed and not let their system become grounded. There is nothing in the three-wire system requiring the neutral wire to be grounded; it is merely a convenience and saves locating and remedying grounds as soon as they occur. It is another one of the cases mentioned before in these columns, which show the consequences of claiming the earth.

Bold Suggestions for the Transmission of Power. THOSE who have followed the recent progress in the transmission of power will doubtless read with some awe the bold proposition made by Prof. Elihu Thomson for the transmission of power on a large scale. Coming as it does from one of the best authorities in America, who differs from some others in that he usually accomplishes what he says he can accomplish, it can hardly be looked at as a wild scheme. When Prof. Thomson speaks of transmitting 130,000 horse power 240 miles at 500,000 volts through three wires of about No. 12 B. & S., or about as large as a good sized knitting needle, and to send this underground, too, through a small pipe, using only cotton and cheap oil as the insulator, and then adds to this his opinion that it would be "practically safe"—we cannot help admiring his courage. With such propositions made in earnest by a reliable party, we may certainly look upon the transmission of power as at present the most important of the numerous developments of electrical engineering. It is interesting to note, too, that he proposes to accomplish this by means of three-phase alternating currents, such as were used at the Lauffen experiment. He also proposes to supply the central stations of a city like New York with cheap electrical power instead of with expensive coal. It is a curious coincidence that in this same issue containing this proposition of Thomson's, we publish a statement of another esteemed authority Mr. Tesla, to the effect that there will be no necessity in the future to transmit power to great distances, because we will be able to get cheap power—extract it, as it were—at any place in the universe. Electrical engineering is certainly making progress.

Early Experiments in Slaughtering by Electricity. "NOTHING new under the sun." The accidental killing of people by electricity has brought up once more the question of slaughtering cattle by this means, in the abattoirs of Aberdeen. The only doubt seems to be whether such a process will have a detrimental effect on the quality of the meat, a question which naturally was not discussed in the application at Sing Sing. If the Aberdeen authorities would look in some of the archives of the year 1799* (nearly a hundred years ago) they will find an answer to their question. A Mr. Atchard there reports having noticed that flesh, and also grain used for brewing, fermented much more rapidly after a storm. Thinking electricity was the cause he tried several experiments. He killed several fowl with electric shocks, while others were killed by sticking a needle through their heads. The former putrefied much more rapidly, and in proportion as the shock had been greater, and he concludes from this that "electricity accelerates corruption." He also "sent a number of strong shocks through a portion of rye, used for brewing," and finds that the fermentation is accelerated. In the year 1749 (Letter of Benjamin Franklin to Peter Collinson, April 29, 1749), the greatest electrician of that day is reported as having made experiments in his home in Philadelphia on killing fowls by electricity. "He conceited, as himself says, that the birds killed in this manner eat uncommonly tender." He also proposed placing an electric machine on one side of the river Schuylkill and by carrying the spark to the other side use it there to kill a turkey, roast it by an electric jack in a fire kindled by electricity and finally to "drink the health of all the famous electricians in England, Holland, France and Germany in electrified bumpers under the discharge of guns from the electric battery." A footnote explains that an "electrified bumper" is a glass of wine electrified, as a Leyden jar, so as to give a shock "if the party be closely shaved and does not breath on the liquor."

* London *Philosophical Magazine*, Vol. III., p. 51.

A Fundamental Patent for Alternating Currents. IT would be interesting to know who makes the most money from United States patents, the inventors or the lawyers. It seems sometimes as if our patent office methods were arranged for the benefit of the lawyers rather than for the inventors. A patent has just been issued which appears to claim broadly the transmission of electricity by means of high tension alternating currents, which are transformed at the distant station to low tension currents by means of some induction apparatus. As this appears to cover a broad field, embracing practically all the already existing alternating current installations, and will include many similar installations of the future, it appears to be a matter of importance. The greater part of the text and claims are given in another column. Being issued, it carries with it the indorsement of the patent office that the matter is patentable. As it was patented in France by the same parties as early as 1881, or 11 years ago, it cannot run very much longer in this country, but if it can be sustained it will play an important part in the alternating current industry of this country even for the short remaining period of its life. Deprez, the patentee, was one of the earliest workers in this field, and it can be assumed that he has furnished good proof of priority to the patent office. The immediate effect will probably be litigation, and there will be much of it, too, if there is any chance of its being sustained. That such an occurrence is possible in our patent office is unfortunate, and cannot fail to have a very bad effect on the investments in patented articles in this country. As it is, any one who wishes to start the introduction of some article, patented or not, will never know if there is not some fundamental patent lying dormant in the patent office to be thrust upon him unexpectedly at some future date, after he is well established in an honest business. Such a law is like some others in this country, for the benefit and profit of lawyers rather than for the good of the people. Let us hope the patent will prove to be a dead letter rather than a legal monopoly or even only a scarecrow.

Tesla's Lecture in Paris. IT appears sometimes as though there was an opinion abroad that Americans, though practical, are not patient, scientific investigators. It is true we do not spend our time with such matters as calculating π to 300 decimal places, a thing which we understand one of our European cousins has accomplished, and if he expects praise from us he will be disappointed, as we can admire nothing but his patience. Nor do we spend our time in working out with great care abstruse matters that do not promise some useful results. There is generally to be seen in the work of our investigators the desire to get at some practical result which can be turned to use in the industries, and it is therefore probably often the case that such investigations are not made public until some practically useful results have been arrived at. Mr. Tesla's researches are a good illustration of the nature of the work done by one of our investigators, and they certainly may be classed with the most useful and novel researches made abroad. Judging from the great interest which they have awakened abroad, they are regarded there also as among the most novel, interesting and promising of all recent investigations. They differ from many European researches in that they open up a new field in which it certainly looks as if some highly useful and practical results could be attained. There are difficulties in the way, but, though great, they are apparently not regarded as discouraging to this indefatigable investigator. That our present method of generating light is even less economical than the generation of power by means of the steam engine is well known to those who have studied the efficiencies of our light-producing devices. The arc light is at present the most economical method known, of those commercially in use, but even this leaves a tempting field for the investigator to discover improvements. The firefly and other organic generators of the "ideal" light have shown us that there is a way of generating light economically and without the accompaniment of useless and expensive heat. Mr. Tesla's researches appear to point out the direction in which we may approach this ideal; he has, in fact, already produced a bright light by a new method. How efficient it is does not seem to have been determined yet, but as it appears to approach the ideal "cold light," it probably will prove to be much more economical than the forms used at present. It remains, still, to make it practically applicable. Let us hope he will soon accomplish this also.

The Grounding of the Neutral Conductor on the Three-Wire System.

As was mentioned in the columns of THE ELECTRICAL WORLD some time ago, the New York Board of Underwriters has been making investigations as to the alleged danger arising from the practice of grounding the third wire of the three-wire system as practiced by the Edison company in New York City. As the result of this investigation the board condemned the practice as unsafe, and passed a resolution ordering that it be discontinued on penalty of a withdrawal of the service of the board.

This very important resolution, as will be readily understood, amounts to a peremptory mandate, as the Board of Underwriters now includes every company doing business in New York City, with four exceptions. It will be of interest to all electric light companies whose circuits are operated on the three-wire system. The advisability of this practice has often been discussed at the annual meetings of the Association of Edison Illuminating Companies.

The investigation which resulted in this action of the board was based on the report from the Committee on Police and Origin of Fires which took form in the passage of the following resolution:

Resolved, That the Committee on Police and Origin of Fires be and they are hereby directed to require all electric companies furnishing current for power and lights (to parties that have received certificates of approval of electrical equipments from this board) to make regular weekly reports of the tests of their currents, as called for in the requirements of this board, and in the event of failure on the part of the electric companies to do so, then the Superintendent of the Survey Department is hereby directed to decline to grant certificates or make inspections of equipments supplied with current by said delinquent companies; and further

Resolved, That said committee give notice to all electric companies receiving certificates from this board that the intentional grounding of any portion of the equipments is a violation of the rules of this board, and such practice must be discontinued. This board will refuse certificates of approval of all companies who do not comply with this rule; and, further

Resolved, That the committee require of electric companies that all grounds now existing on electric circuits shall be removed on or before Oct. 1, 1892.

The Committee on Police and Origin of Fires was aided in its investigations by Prof. Henry Morton, of the Stevens Institute of Technology. Prof. Morton's report was read at the meeting of the board last week. He stated that in his opinion the grounding of the electric wires decidedly decreased the fire risk for the following reasons:

First.—If all the wires are insulated then two ground contacts must occur in order that fire should be produced by the contact of a conductor with gas, water, or steam pipe, or other conducting substance connected with the ground. If, on the other hand, the middle wire is "grounded," then every gas, water, or steam pipe becomes in fact a "live wire," contact with which will result in a current, only limited in amount by the capacity of the conductors (including fusible catches and the like) between the point of contact and the general network of supply wires.

Second.—It renders entirely impossible any testing by which from time to time the insulation of the system can be watched and measured. As a result, when a "ground" occurs, unless it attracts attention in its own neighborhood or is enormous in amount, it can go on indefinitely without being discovered, while it may be doing mischief all the time, whereas with an insulated system a ground will instantly show itself by the proper instruments at the central station or elsewhere, and at the same time will be harmless until another ground on the wire of opposite polarity is developed.

If the middle wire of the Edison system is grounded the entire system is then in such connection with the earth that the contact of either positive or negative conductors with water, gas or steam pipe, or iron parts of the building, or other conductor, will establish a connection through which a large current will flow. I found by actual experiment that if I connected a bank of 10 incandescent lamps with steam, gas or water pipes or other conductors in connection with the ground, I could operate as many of these lamps as I choose to connect with the Edison wires within the carrying capacity of the nearest so-called "safety fuse."

A vigorous protest was entered against Prof. Morton's report by Vice-President R. R. Bowker of the Edison Illuminating Company of this city. Mr. Bowker said: "We would emphasize to you that our street system is in no sense dependent upon the practice of grounding the neutral, and that, contrary to the inference of Prof. Morton's report, no copper or other element of cost is saved with that practice in view; the motive of the practice is not commercial, but precautionary. We remind you also that the practice is in vogue in other cities with the approval of underwriters. We would also beg to correct the misapprehension that there is any grounding of the neutral wire in houses, or any decrease of insulating precautions because of that practice.

"We ask your board for such modifications of your rules as will recognize the features of the three-wire system and provide for the practice thus adopted. We beg herewith, however, to say that should the board, in full view of the protest of this company, decide to take the responsibility, with the insuring community and before the public, of directing this company to discontinue the practice, the superintendents of the company will have instructions to prepare to disconnect the neutral grounds at the junction boxes throughout the city, which would require, however, considerable time, and would not, we believe, produce the result desired of giving opportunities for insulating tests on the lines of laboratory practice and of special circuit systems. We would, moreover, enter definite protest against the overruling of this company by your board in a question of practice which we believe can best be determined by working electrical engineers familiar with the needs and conditions of actual station practice."

Mr. Bowker then gave a detailed description of the Edison three-wire system as in use in New York and Brooklyn, and gave his reasons for the assertion that it was entirely safe and practical.

Death of Mr. Chas. J. Van Depoele.

Mr. Charles J. Van Depoele, one of the pioneers of electric traction in this country, died at his home in Lynn, Mass., on Friday of last week. Mr. Van Depoele's sickness has extended over a period of nearly four months, but the immediate cause of his death was an attack of pneumonia. As is well known by our readers, he has been connected for the last few years with the Thomson-Houston Electric Company, making his headquarters at the company's factory in Lynn, and since joining the engineering staff of that company has given a very large part of his time to designing special apparatus for the application of electricity to mining work.

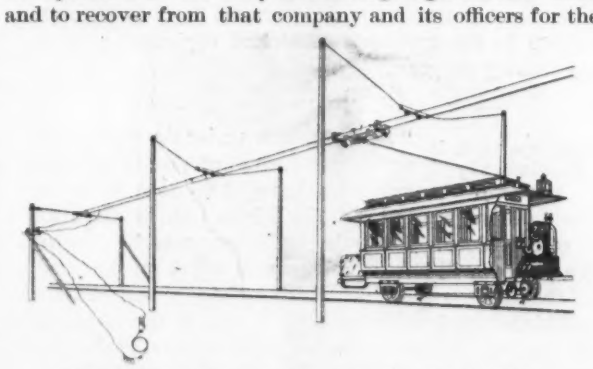
CHAS. J. VAN DEPOELE.

Mr. Van Depoele was born at Lichtervelde, Belgium, in 1846. With his father he removed to Lille, France, in 1864, where, disliking the furniture business in which his father was engaged, he secured a position in the sculpturing ateliers, where some 250 artists and artisans were employed, and where he soon rose to the rank of foreman. In 1849 he came to America and located at Detroit, where with a Belgian friend he started the manufacture of art furniture. In 1877 he built an electrical laboratory and there constructed a number of dynamos with which exhibitions were given and from which his large shop was brilliantly lighted by arc lamps. In 1881 he established himself in Chicago, a company having been formed in which Gen. A. K. Stiles was chief stockholder. In less than a year 100 men were employed in the shops of this company and a successful business was well under way. Although considerable attention was directed to the development of his arc light system, Mr. Van Depoele was also working upon the various questions involved in the electrical transmission of power, and working along this line he devised a system of telpherage, and several schemes for driving tools by electric motors. His first experiments in the propulsion of street cars by electricity were made in 1882, and the first commercial road was equipped in 1885 at South Bend, Ind. Within three years from that time Mr. Van Depoele had 13 roads in operation on the overhead system. In March, 1888, the Van Depoele Company was absorbed, so far as the electric railway system was concerned, by the Thomson-Houston Electric Company, and Mr. Van Depoele joined that company as the electrician of the railway department.

The records of the United States Patent Office bear evidence of Mr. Van Depoele's industry and to his ingenuity and fertility as an inventor. From 1880 to 1892 224 patents were issued to him as follows: 1880, 2; 1881, 1; 1882, 8; 1883, 19; 1884, 17; 1885, 14; 1886, 26; 1887, 4; 1888, 13; 1889, 40; 1890, 45; 1891, 30; 1892, 5. About 100 of these patents pertain to electric railway work, 40 to electric reciprocating apparatus, such as electric drills, pumps, reciprocating engines, etc., and the others to general electrical apparatus, including arc and incandescent lamps, dynamos, induction motors, etc.

Electric Railway Litigation.

A bill of complaint has been entered in the United States Court for the Northern District of New York which deserves more than a passing notice. The bill seeks to enjoin the operation of the Troy & Lansingburgh Electric road and to recover from that company and its officers for the infringement of United States patents Nos. 345,845 and 424,298, granted to John C. Henry. These patents over which the controversy has arisen, it is claimed by the plaintiff, cover the entire trolley system of operating electric roads exclusive of the motors and dynamos. Mr. Henry's application for the first of these patents was filed on Oct. 17, 1885, and the patent was granted July 20, 1886, and for the second on Jan. 16, 1885, the patent being issued March 25, 1890.



DRAWING FROM HENRY'S PATENT NO. 424,298.

We have reproduced one of the figures from Mr. Henry's patent specification bearing the earliest date of application. The claims accompanying this specification on which the bill of complaint is partially based are given herewith.

Claim 1.—In combination with one or more electric conductors, an insulating block, whereto they are connected centrally over the street, and wires supporting said blocks from two sides of the street.

Claim 6.—In combination with an electrical conductor of an electric railway supported over the street by transverse guy-wires, a traveling contact having grooved faces held by spring pressure against the sides and bottom of the conductor.

The claims of the other patent upon which the litigation is based, are claims 4, 5, 10, 11, 14 and 15, of which three are as follows:

Claim 4.—In electric railways, the combination, with the generator, of conductors for the transmission of electrical currents in double multiple arc, consisting of a series of conductors alternating in polarity and connected in pairs to the opposite poles of a generator.

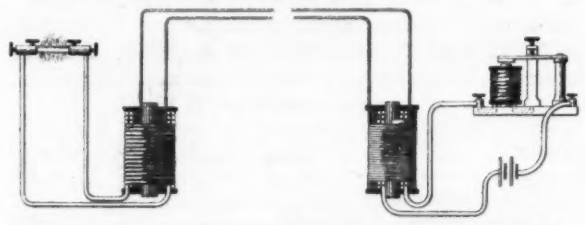
Claim 5.—In electric railways, the combination, with a main source of electric supply, of suitable suspended continuous aerial conductors and buried insulated conductors and branch conductors of corresponding polarity, and connected at intervals with the aerial conductors.

Claim 15.—In electric railways, the combination, with the curved track of parallel aerial conductors and arranged to describe the curve of said track, and insulated standards placed upon one side of the said parallel conductors at suitable distances apart, and guy-wires secured to the top or side of each respective conductor, and means for increasing or decreasing the tension of said guy-wires, as described.

A Broad Patent on the Transmission of Electrical Energy to a Distance.

A patent was issued last week to Marcel Deprez and Jules Carpentier, of Paris, France, by the United States Patent Office, which is of importance to all who are interested in the long distance transmission of electricity, a subject which seems to be the leading topic of the day. The subject of the patent is the "Transmission of Electrical Energy to a Distance," and seems to cover broadly the method of transmission by means of step-up and step-down transformers. The application was filed in the United States Patent Office, Nov. 27, 1888, after having been patented in France, April 5, 1881, and in Great Britain on Sept. 24 of the same year. For the information of our readers we have reproduced the drawing accompanying the specification and give in addition those parts of the patentees' description which explain the features upon which they have secured a patent.

The specification says: "The novel feature of our invention consists in sending over a line to a distant point maintained and practically uniform currents of high tension and comparatively small quantity, through a primary coil of many convolutions, and thereby generating by induction



DRAWING FROM DEPREZ AND CARPENTIER'S PATENT No. 470,865.

similar currents of lower tension and greater quantity in a secondary coil of a lesser number of convolutions."

A generator of alternating currents of high tension is located at one station, and a Ruhmkorff or other suitable inductorium is located at a distant station, the two being connected by line conductors, which include in circuit the primary coil of the inductorium at the distant station. This primary coil is preferably made of fine wire, and has a great number of convolutions, and the alternating currents of high tension passing over the line also pass through the convolutions of the primary coil. The secondary coil of the distant inductorium is made of a comparatively small number of convolutions, and is preferably made of a much thicker wire than the primary coil, and the high tension currents in the primary generate inductively in the secondary coil currents of much lower tension and of great quantity. In the external circuit of the secondary coil at the distant suitable translating devices are included, requiring the employment of maintained and practically uniform currents, and these translating devices are represented in the drawing as a platinum wire stretched between binding posts or clamps. The generator of alternating high tension currents is shown as composed of a Ruhmkorff coil, having a short thick wire primary coil connected in circuit with a battery and a rheotome of ordinary construction, while the long fine wire secondary coil is connected with the line conductors.

The inventors say, after describing the apparatus: "Thus it will be seen that by our system of transmitting electrical energy to a distance the currents traversing the line conductors are of high tension and comparatively small quantity, and the line conductors may therefore be made quite small and inexpensive, while the amount of energy which can be transmitted to great distances by such conductors is practically unlimited."

One of the claims of the patent as issued is as follows:

"The improvement in the art of transmitting electrical energy to and utilizing it at a distance from the source, which consists in generating maintained and practically uniform alternating currents of high tension at one station and sending the same over a line of conductors to another station, generating maintained and practically uniform alternating currents of lower tension at the second station by the inductive influence of the high tension currents, and converting these maintained low tension alternating currents into other forms of energy, such as heat, light, etc., substantially as described."

Tesla's Experiments with Alternating Currents of High Frequency.*

BY E. RAVEROT.

The phenomena produced by alternating currents of great frequency and very high potentials were exhibited in public for the first time in France, on Friday, Feb. 19, by the discoverer. The event was one of great importance, as the first experimental presentation before the physicists and electricians of France of an entirely new field of research. Physics, after having created the scientific industries, now receives from them in return very valuable means of investigation which assure the investigator a rich harvest of discoveries. When we consider the researches of Planté with the secondary battery, and witness the discoveries of Tesla with his powerful induction coils, the proof of this assertion becomes evident, and the field of future developments in store for experimental physics grows brighter.

In the light of the experiments of Mr. Tesla we can understand more clearly many of the mysterious phenomena of the radiant state of matter pointed out by Prof. Crookes, of phosphorescence and the molecular bombardment; they lead us to clearer ideas of several contested points in the theory of electricity.

The limited time did not permit Mr. Tesla to dwell as much as he would have wished upon the theory and the arrangements of the experiments, and we must content ourselves here with giving simply the personal impressions

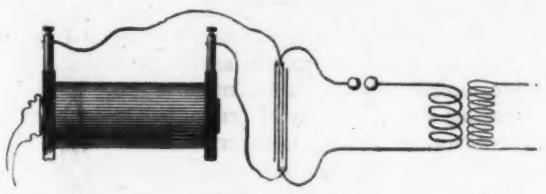


FIG. 1.—DISRUPTIVE DISCHARGE THROUGH THE PRIMARY OF A TRANSFORMER.

of a charmed listener who will endeavor to state what he saw or what he believed he saw.

In order to produce the currents of the very great frequency and very high potential necessary for the experiments, recourse was had to two methods. In the one he employs a multipolar alternator of his own design, giving directly a frequency of 15,000 to 25,000 alternations per second. In this machine (which is the same as that used in his lecture in New York†) the field magnets are fixed and consist of a forged iron ring 81 centimetres in outside diameter and about 2½ centimetres in breadth, having 384 polar projections, between which are wound in a zigzag form two wires, to constitute the exciting circuit for the magnets. The inside diameter of this stationary field is about 76 centimetres. The movable armature is made of a disc, on the surface of which are located the windings, attached laterally by strong pins. The speed of the machine varies between 2,000 and 3,000 revolutions per minute; it can generate as much as 10 ampères. The potential of the machine is regulated by means of a condenser. The current from it supplies the primary circuit of an induction

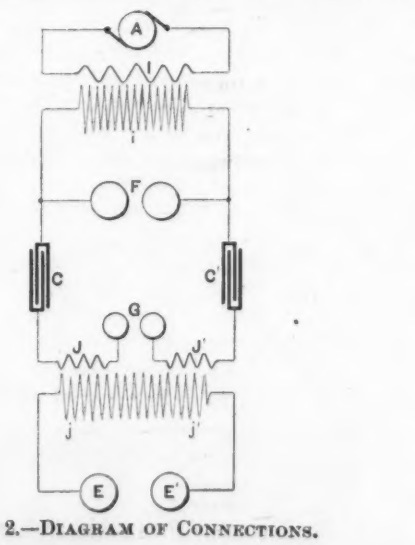


FIG. 2.—DIAGRAM OF CONNECTIONS.

coil of special construction, of which we will speak later on.

The other method used by Mr. Tesla to obtain the enormous frequencies of 300,000 to 400,000 alternations per second and the exceedingly high potentials of over half a million volts, is based on the employment of the disruptive discharge of a condenser in combination with induction coils of peculiar construction. Fig. 1 shows this arrangement of apparatus, which was already described in his former papers. Fig. 2 shows a diagram of the disposition of the apparatus and connections which, however, Mr. Tesla did not stop to describe; we give it here as we remember it, and if there are any errors they are on our part. From the connections shown it seems to us to represent the general disposition of the apparatus used in the experiments which we witnessed.

On this diagram, *A* represents a Siemens alternator which generated the initial energy of the primary circuit *I* of the first induction coil of the transformers. In the secondary circuit *i* of this transformer are connected symmetrically condensers *C* and *C*¹, the disruptive discharge of which passes with the desired frequency through the primary circuit *J J*¹ of the second transformer, the secondary circuit of which terminates at the poles *E* and *E*¹, where the currents of high frequency and enormous potentials may then be led off. *G* and *F* are discharge knobs intended, apparently, to regulate the frequency of the disruptive discharges. We call attention to the function of these adding, however, that our impressions as to their function were obtained by a single inspection of the diagram and connections, but that we do not guarantee that our views are correct. The same is said with regard to Fig. 3, which shows the transformer used by Mr. Tesla, which was drawn from memory. Regarding this transformer Mr. Tesla stated that the length of its secondary wire is only

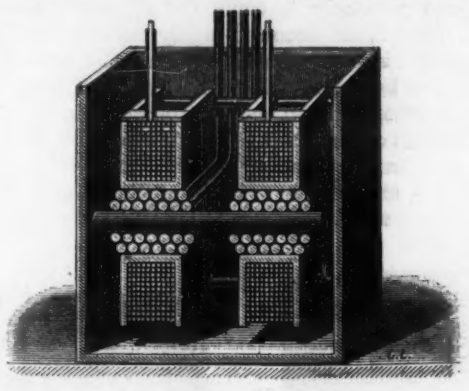


FIG. 3.—HIGH FREQUENCY TRANSFORMER.

from 60 to 100 metres. It gives as high as half a million volts when its primary circuit is excited by the disruptive discharge of the condensers, with a frequency of 300,000 to 400,000 alterations per second. The transformer ratio is one to six and the number of windings of the primary coil is 300. The entire coils are placed in a tank filled with oil. This is indispensable under the condition of such high voltages and such great frequencies.*

The principle of this method is based on the phenomenon of resonance which requires very delicate and laborious regulation and adjustment. Mr. Tesla dwelt repeatedly on this difficulty, and illustrated the same with experiments, which could have been shown also by calculation; the chief obstacle in this is the uncertain knowledge of the

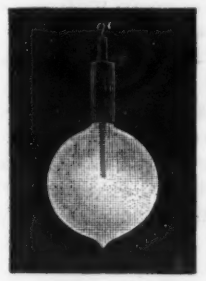


FIG. 4.—UNIPOLAR LAMP.

effective capacity of bodies separated by air, that is, the effect of convection or of absorption.

The second method shows the important part which condensers take in all the experiments of Mr. Tesla, the electrostatic function of which shows clearly the nature of the observed phenomena.

Mr. Tesla also pointed out the analogy of the effects produced by his induction coils for high frequency with those produced by the Wimshurst machine. He can produce phenomena and sparks with his apparatus absolutely identical with those which are ordinarily observed with such influence machines. In seems, in fact, that many of the experiments shown ought to succeed equally well under similar conditions with the discharges from his coils and with

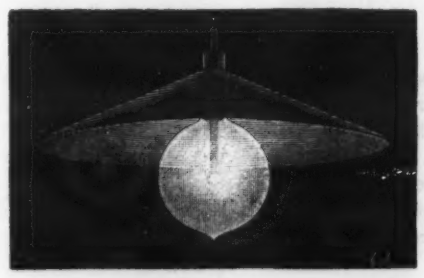


FIG. 5.—LAMP WITH A SHADE AS A CONDENSER PLATE.

those from an electrostatic machine. If, for instance, one pole of a small radiometer of Crookes be connected, the radiometer is put in motion, at least when the conditions of resonance of the circuit are favorable. At the lecture the radiometer, when attached by only one pole, was at first immovable, but started to move when a plate of a certain capacity was connected to the second electrode of the radiometer bulb.

The operation of the radiometer of Crookes, attributed to the unequal molecular bombardment produced on the two different surfaces of the fans, is analogous to the unipolar effects produced at each one of the two poles of the high tension transformer of Mr. Tesla. One can understand now the statement of Mr. Tesla in his former publications, that he utilizes in his experiments the "molecular bombardment" and "the condensing action." We recall also a statement of Mr. Tesla in his former publications that "every body, whether a conductor or susceptible of conducting a current of high tension, can, if it be inclosed in a properly exhausted tube, become luminous or incandescent when it is connected directly to the pole of a secondary circuit of the source of energy excited by induction."

Such are in effect the conditions of operation of Mr. Tesla's unipolar incandescent lamp. At the end of the conducting wire is placed a knob of conducting matter which

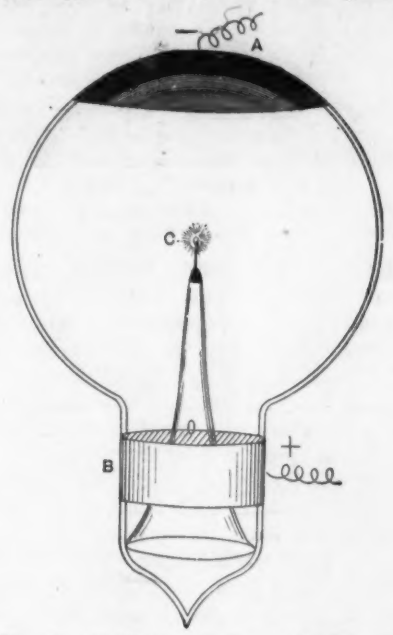


FIG. 6.—AN EXPERIMENT OF CROOKES.

is placed in a bulb from which the air is exhausted, like in the ordinary incandescent lamp; this knob becomes illuminated with a brilliant light when the wire is connected to one pole of the high frequency transformer. The lamp is shown in Fig. 4. The knob is subjected to the molecular bombardment of a rapidly varying electrostatic field. The nature of the phenomenon is made evident when the intensity of this field is increased by the operator bringing his hand near the bulb, his body communicating through the ground with the other pole of the transformer. Another remarkable and very useful quality of the unipolar lamp of this inventor is that of being able to vary the amount of light at will by simply changing the electrostatic capacity of the system. Mr. Tesla utilizes this property in a curious manner by employing as a plate condenser a lamp shade in the form of a reflector as shown in Fig. 5.

This recalls us to the experiment of Prof. Crookes* shown in the course of his researches, of the passage of an electric discharge in a high vacuum. A small piece of char-

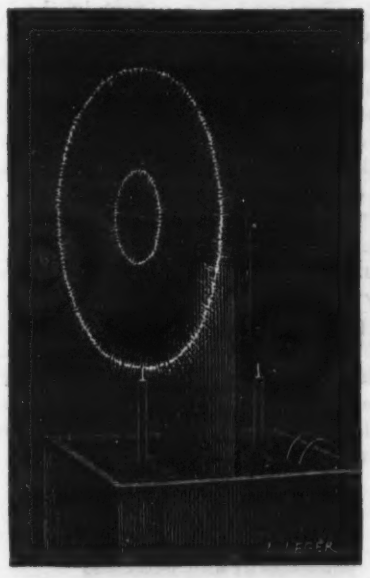


FIG. 7.—INCANDESCENCE OF WIRES BY MOLECULAR BOMBARDMENT.

coal placed at *C* (Fig. 6) in a bulb exhausted to the extreme vacuum of one ten-millionth part of an atmosphere is brought to incandescence under the influence of molecular currents.

In the course of his investigations Mr. Tesla has varied the dimensions of the bulbs of the lamps between great extremes. The relative size of the incandescent knob, and the degree of rarefaction in the bulb, are conditions which require very careful examination and determination. He presented to the audience numerous facts showing the complexity of his investigations and the great amount of patience which is required.

Not being able to go at greater length into this subject we must content ourselves with pointing out merely the chief experiments by which he showed the very great influence of the relative proportions of the parts and their relation to the high frequency transformer. In connecting the poles to bare wires or even to wires covered with an insulating substance, and interposing a plate of very high in-

* *La Lumière Electrique.*
† See THE ELECTRICAL WORLD, July 11, 1891.

*This reminds us of the first great induction coil of M. Jean, which was insulated with the essence of turpentine. (Du Moncel, "Notice sur la Bobine d'Induction," p. 40.

* "L'Electricité et son Trajet," par William Crookes. *La Lumière Electrique*, vol. XXXIX., p. 337.

sulating material (in order to avoid direct discharges), the wires will be seen to become radiant along their entire length, with a small crackling light, resulting from the direct or outside bombardment on the whole surface of the wire. Fig. 9 shows the appearance of two concentric circles showing this phenomenon in one of its finest forms. Another similar phenomenon is shown in Fig. 8, in which a very fine wire, invisible by itself, radiates brilliantly when connected to the high frequency transformer.

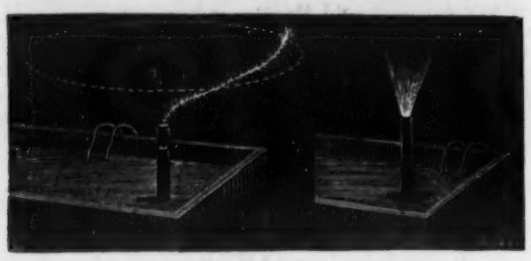


Fig. 8.—Incandescence and Movement of a Fine Wire.

Fig. 9.—Unipolar Flame from a Transformer.

Under slightly different conditions a conductor of a certain capacity in the form of a metallic plate was connected to one pole, and there then appeared on the other pole a true flame, as shown in Fig. 9. This experiment suggested to Mr. Tesla some very original thoughts on the constitution of ordinary flames, the nature of which might be connected in some way with the phenomenon of molecular bombardment produced by the rapid variations of chemical energy and the equalization of the affinities.

The discharge in the form of a flame is one of the five typical forms of the illuminating discharges which Mr. Tesla brought out in his orignal paper.

The discharges vary in form, depending on the frequency, the capacity and the potential; if, for instance, the poles of the high frequency transformer terminate in two poles, the discharge takes the form of a spark depending on the dimensions of the electrodes of the exciter. In this connection one of the most curious experiments shown is that indicated

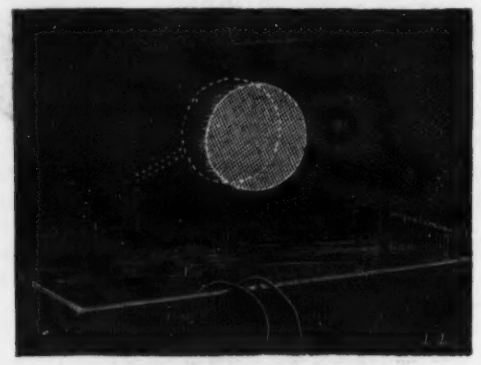


Fig. 10.—Heating of an Ebonite Plate by High Frequency Discharge.

in Fig. 10. The discharge passes at first in the form of a simple spark or of an arc between two discs, one of which is made of metallic cloth. The interposition between these of an insulated plate of ebonite, instead of simply obstructing the passage of the arc, increases the condensing action and substitutes for the arc a form of discharge which fills all the space between the discs; the heating action on the ebonite manifests itself to a great degree.

During the lecture Mr. Tesla took a ball of copper in each hand, and by means of them touched the two poles of the high frequency transformer; he then received through his body the full potential of 70,000 volts developed in this transformer of 9,000 ohms. It certainly is not one of the least curious effects of enormous frequency that it renders harmless to the human body currents the danger of which is only too well known when the frequency is low. The investigator remarked to the audience that when he first

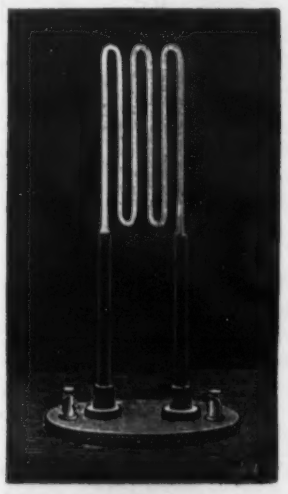


Fig. 11.—Unipolar Illumination of an Exhausted Tube.

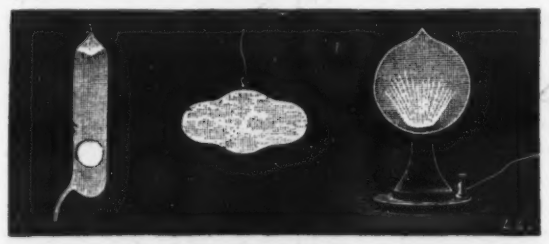
tried this experiment he felt like a man about to jump from the Brooklyn Bridge. In the whole course of his experiments Mr. Tesla was not afraid to hold in his hands the lighting apparatus and to use his body as a conductor. The action of the body is due as much to its induction effects resulting from the approach of a conducting surface as to its conductivity. The discharges of excessive frequencies do not, in fact, require two-wire conductors for their transmission. If, for instance, one pole is connected to one end of the exhausted tube shown in Fig. 11 the tube will be illuminated, but it will be brighter at that end to which the wire is connected, and will gradually grow less bright toward the other end. It suffices, however, merely to connect to the other end of the tube a conducting or semi-conducting body having a sufficiently good conducting surface, in order to make the illumination equal throughout the whole tube. The body which is connected acts as a real diffuser through which the discharge is disseminated into the surrounding air, which therefore replaces the return conductor. The same effect is produced with a lamp having two carbons instead of one, as shown in Fig. 12. If one pole only is connected to one terminal of the transformer, it becomes highly incandescent while the second one is only slightly illuminated. An interesting feature to be noted here is the shadow thrown in the bulb by the second carbon and its support. It suffices, however, merely to connect to the second carbon a body having the proper capacity, in order that both may burn equally bright. This experiment was one of those in which the light produced was of the greatest intensity; it was like

Fig. 12.—Unipolar Incandescence of a Lamp with Two Carbons.

Fig. 13.—Lamp with Double Bulb.

that of one of the ordinary incandescent lamps with carbon filaments when forced to a very high candle power. Mr Tesla furthermore pointed out that the carbon knobs of these lamps can also be illuminated entirely by induction a phenomenon which he pointed out in his earlier papers. They are in this case furnished with condensing armatures placed on the outside and inside of the bulb. Such an arrangement obviates the necessity of introducing wires through the bulbs and therefore permits them to be hermetically sealed without a break in the continuity of the bulb. The energy is transmitted entirely in this case through the glass. The induction is, perhaps, in this case the cause of the lowering of the efficiency of these lamps, which otherwise ought to be very high. Fig. 13 shows an arrangement of two concentric bulbs as made by Mr. Tesla in order to diminish the action of the air in contact with the bulb. The space intermediate between the two bulbs is exhausted to a less degree than that in the inner bulb and appears to act like an interposed conductor. This arrangement, however, increases the temperature of the interior bulb.

The question of the life of the substances subjected to



Figs. 14, 15, 16.—Phosphorescence from a High Frequency Discharge.

the molecular bombardment in the bulbs is one of the features which require very careful investigation in order to render such lamps practical. In the beginning of his researches Mr. Tesla used for the incandescent knobs carbon prepared like that for the filaments of the ordinary incandescent lamps, and treated with hydrocarbons. He obtains more satisfactory results now with a variety of pure carbon prepared by Mr. Atchison and known by the name of *carburendum*, as nearly as we can remember from the pronunciation.

In the course of his investigations he was led to the very interesting and particularly fascinating study of phosphorescent bodies. With his high frequencies and exceedingly high potentials the phosphorescence in the path of the discharge acquires a degree heretofore unknown. Figs. 14, 15 and 16 give but a poor idea of the fine appearance of some Crookes tubes containing calcium sulphide (bright yellow), yttria (green) and rubies (red), resembling strawberries, etc. Mr. Tesla also showed numerous glass tubes having their internal surface covered with phosphorescent matter. In the latter, the phosphorescence of the glass adds its light to that of the matter in the tube; in a large number of cases the action is particularly intense at the equator of the bulb, as shown in Fig. 17. We call attention to the illumination of the glass tube, in spite of the thin layer of metal deposited on its surface, which, as might at first appear, ought to obscure the light.

The great variety and number of experiments shown and mentioned by Mr. Tesla showed the activity with which he has pursued this captivating problem of alternating currents of very high frequency. He is now studying the question as to how far such effects may be utilized and conducted to a distance. The great difficulty which the insulation of such conductors presents is evident; their surface, whether

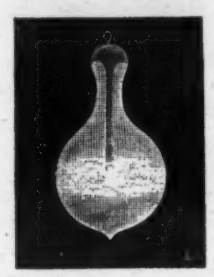


Fig. 17.—Equatorial Phosphorescence of Globes.

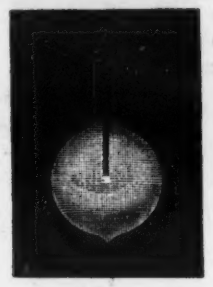


Fig. 19.—Sensitive Unipolar Discharges.

bare or covered with any insulation whatsoever, remains exposed to the molecular bombardment. He spoke of a wire having the ordinary protection of a continuous insulating covering which is surrounded by an armature, which acts as a condenser. A unipolar lamp will burn with a different intensity when it is connected to the conductor itself or to the exterior metallic cover. Mr. Tesla expects to get good results from a system of static screens formed by a metallic protection in short lengths around the wire.

In this connection he made an allusion to some hopes he had regarding the possibility of transatlantic telephony, which, however, we did not quite understand. As to the transportation of energy to a distance, by currents of such great frequency, he says that there will be no necessity felt for such a transportation, as one would then know how to obtain the energy and motive force in any point or place in the universe. To illustrate this he mentioned that the radiometer of Crookes operates anywhere, in the light as well as in invisible heat, and according to his views this machine is one of the most inefficient known. Under the

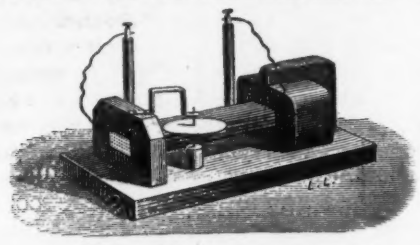


Fig. 18.—Motor Working with Alternating Currents of High Frequency.

conditions in which these unipolar lamps are lighted, there is nothing to hinder one from gathering the energy in a form suitable to drive a motor. Fig. 18 shows such an apparatus in the form of a motor turning from the impulses of discharges of high frequency traversing a solenoid wound around the ends of a bundle of iron wires. The movable part is a copper disc unsymmetrically situated relatively to the bundle of wires. The general analogy of the form of this with the gyroscopic apparatus of Messrs. de Fonvielle and Lontin (and others) appears very curious. Does it not indicate the identity of the action of currents whose frequencies are very different from each other? As an incidental experiment the rapid heating of a piece of iron subjected to the action of the discharge currents was pointed out.

Mr. Tesla furthermore described a phenomenon capable of application to submarine telegraphy, by showing the extreme sensitiveness of the directing action of a magnet (even if very long and very weak) on the discharge in a unipolar lamp as shown in Fig. 19, the electrical processes presenting the subject of the light of the future in

Fig. 20.—Illumination of Rarefied Tubes in the Electrostatic Field.

quite a different aspect than the chemical processes, and Mr. Tesla showed on several occasions the striking experiment which in his opinion shows the ideal method of lighting. His experiment showed that the energy of the electrostatic field produced by the rapid and powerful alternations of a

high tension transformer is capable of being utilized. This is, so to speak, his typical experiment. A metallic plate about three metres in length and one-third of a metre in breadth was suspended about two and one-half metres above the lecturer's platform, as shown in Fig. 20. The electrostatic field was generated in the space in which the lecturer stood, between the plates and the floor, which were respectively connected to the two poles of the transformer. Exhausted tubes of glass more than a metre long, held in the hand of Mr. Tesla in this field, were brilliantly illuminated throughout their entire length as shown in the figure. The light was intense, being almost vivid, and resembling in its tint the light from the moon. One might say it appeared like a luminous sword in the hand of an archangel representing justice. The appearance was very fine and the effect very grand.

But the experiments of Mr. Tesla have, in our opinion, quite a different bearing, as we are tempted to see equally well in the phenomena of the electrostatic field as in the illumination of the unipolar suns of the inventor the experimental confirmation of our own views on the electrostatic nature of light.*

One sees from this lecture the deep interest which the works and discoveries of Mr. Tesla have inspired among physicists since the first appearance of his publication, and it is with great satisfaction that we are able to express the feeling of admiration which his experiments have inspired in us.

* *La Lumière Electrique*, Vol. XXXIII., 1887, p. 108.

Herzog's Electric Horse Power Curves.

Some time ago we published some horse power tables giving the volts, ampères and corresponding horse powers, calculated by Dr. Wheeler and Prof. Crocker. As a substitute for these, which are somewhat cumbersome in many cases, Mr. Josef Herzog, of Budapest, has sent us the accompanying curves, which are so simple and easy to use that they will doubtless prove of great value to the practical engineer. Though not as accurate as the above mentioned tables, they are sufficiently so for probably nine cases out of ten which occur in daily practice, and they are unquestionably handier, smaller, and require less time to use than a large table.

The application of these curves is as follows: The horizontal scale represents volts, the vertical ampères, and the diagonals horse power. To find the electrical horse power corresponding to any given volts and ampères, follow the given values on the volt scale and on the ampère scale, to their intersection, then the diagonal passing through that point will be the required horse power. If the volts and horse power are given, then follow the intersection of their values to the right or left, to the ampère scale, which will then give the corresponding ampères. Or, if the ampères and horse power are given, follow the intersection up or down to the volt section. It will be noticed that the range is very great, being 1,000 volts, 1,000 ampères and 1,000 h. p.

The principle on which these curves are based is also quite simple to any one familiar with the use of logarithms, though it is not necessary to understand this in order to use the curves. The equation

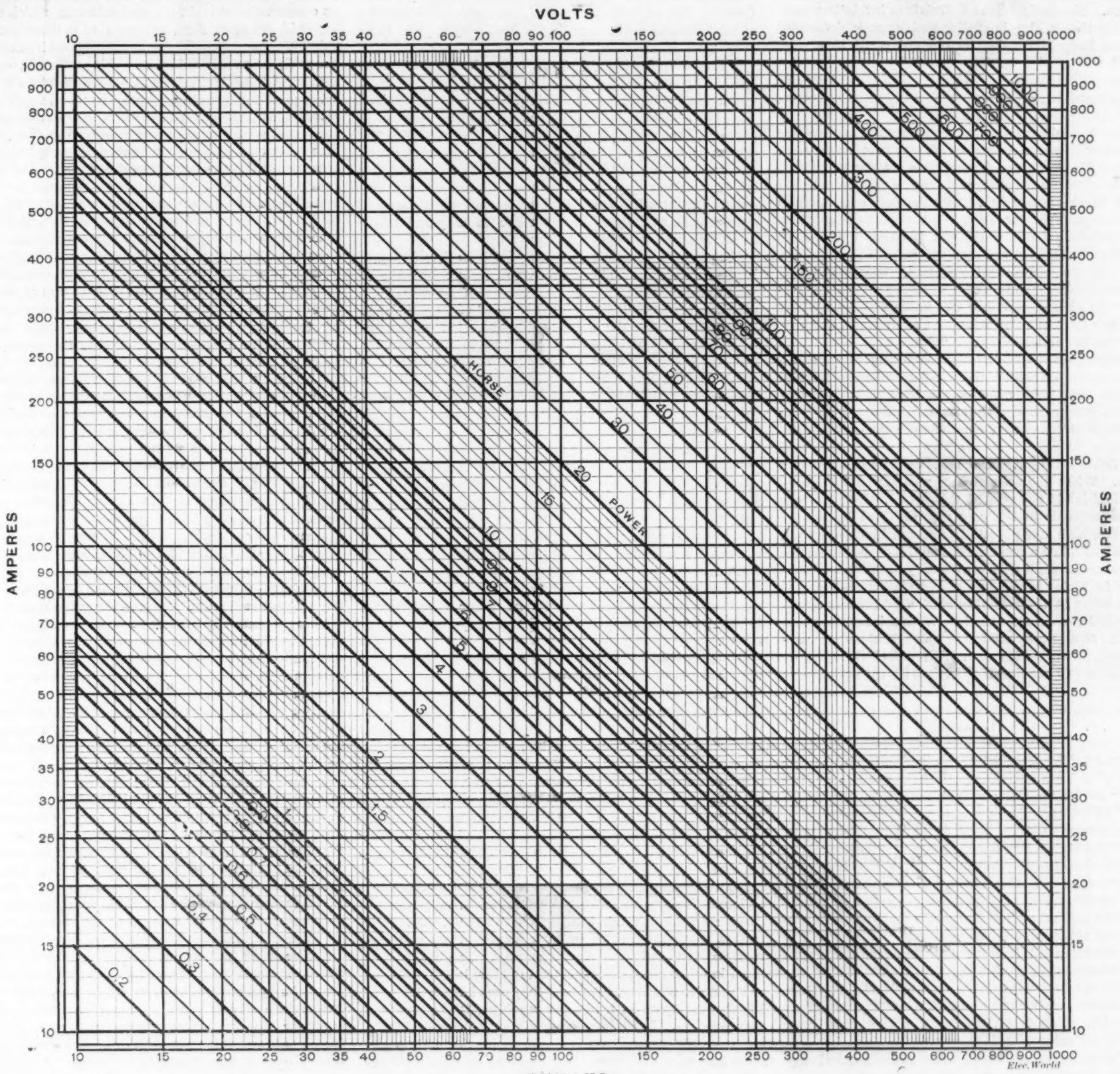
$$\text{Horse power} = \frac{\text{Ampères} \times \text{volts}}{746}$$

may be written

Log horse power + log 746 = log ampères + log volts.

Plotting the logarithms of the ampères and volts along the two axes it will be found that the corresponding horse power lines are a series of straight, parallel, diagonal lines, which is obvious from the nature of the equation.

The same principle may be applied also to other curves if their equations can be reduced to that form. A Swedish engineer named Waldstroem some years ago applied it to wiring calculations. The principle, which is probably not well known, is not new, having been described in a paper of Laland entitled "Mémoire sur les Tables Graphiques," in 1846.



HERZOG'S ELECTRICAL HORSE POWER CURVES.

Electric Cars vs. Blizzards.

The recent blizzard in the Northwest and its effects upon steam roads and general traffic, raging as the storm did for nearly 30 hours, is familiar to the general reader. The storm was especially severe in St. Paul, Minn., and reports in regard to the success or failure of the electric lines to combat its effects have been anxiously looked for by both those who are in favor of, and those who have no use for electric street cars from reasons which they have never been able to intelligently or satisfactorily explain. The difficulties with which the management of the St. Paul electric street railway system had to contend can be readily appreciated by any one who has ever resided in a locality where a genuine blizzard was having its own way, and one can almost see some dyspeptic "croaker" facing the worst of the storm, watching the wheels of the electric motors go round, and waiting for the opportunity, if anything should happen, to exclaim "I told you so." In the recent storm referred to the motors were entirely unprotected against the light drifting snow, and being coupled on in front of the plows had to force their way through the drifts and drag the plows after them. It is stated that there has been no such trial of the system since the lines were equipped electrically, and the test was a severe one, resulting in a complete triumph for the electric railway company operating in that city.

Mr. W. Blakeley, electrician of the St. Paul City Railway Company, in a recent communication to THE ELECTRICAL WORLD, expresses himself as follows: "The only lines we were obliged to suspend were out on the open prairie and were drifted in to a depth of from two to six feet. Strange to say there was not a single cross, ground or breakdown in our 300 miles of overhead wire during the entire storm, the only reports being one loose trolley hanger and one line fuse blown. The velocity of the wind ranged from 20 to 30 miles an hour. I think we can safely say that the electric railway is in to stay."

High Potential Transmission.

BY ELIHU THOMSON.

The electrical engineer, when he has before him the problem of conveying electrical energy through comparatively great distances, without excessive loss and without excessive amounts of copper in the conductors, is compelled to consider the use of high potentials.

Of course, potentials are high or low relatively to others taken as standards, but by a sort of common consent it has come to be regarded that when the electromotive force is sufficient to cause the current to leap, or when there is a striking distance which is easily perceptible, the case may properly be called "high potential."

It implies the existence of thousands of volts potential difference. The strain on the dielectric or insulating material is such that a high insulation resistance is demanded to prevent large leakage. The current passes at a "high tension," or is a "high tension current."

The time at the author's disposal will not permit more than a brief reference to different combinations of apparatus in which high potentials may be effectively employed.

Let it be desired to transmit several thousand horse power from a water power to a distance of, say, 20 miles or more, and deliver it at one point as power. What plant should we use? Direct current or alternating current?

Owing to the difficulty of constructing commutators which are suitable for such high potentials as 5,000 volts, especially where the current is large, it is evident that neither dynamos nor motors can be used in which the full potential is either generated or used. This assumes the use of a direct or continuous current as the means of transmission. In such case either the voltage must be kept down to say 1,500 to 2,000 volts, or the dynamos and motors must be run in series sets.

It is questionable whether commutators can be commercially successful on which the pressure exceeds 1,500 to 2,000 volts, with large currents flowing. They are very difficult to construct and to maintain. Besides, they require to have so many segments between the brushes that the armature winding and connecting is made more delicate and liable to injury. The cost of construction becomes excessive. When the voltage does not exceed 1,000 volts these difficulties do not present themselves. Hence to use continuous currents in the case assumed, and to take advantage of a high line potential to secure immunity from line losses and allow a moderate outlay in copper to suffice for the transmission, it will be necessary to connect several dynamos in series in the generating station and several motors in series at the receiving station. These machines may be belted to a common shaft. With this arrangement it would be possible, by mounting the machines on insulating bases, to work with such high potentials as 20,000 volts by having 20 machines of 1,000 volts each connected in series at each end of the line. This with each machine of 500,000 watts output would transfer energy at the rate of 16,000 h. p.

The machines, both generators and motors, could be series wound and be practically self-regulating as to speed under varying loads, providing all the machines are mechanically driven together as one or deliver power together. The construction presents no great difficulties, and the efficiency under all loads, except quite light loads, could be made high. But the condition of combined driving and delivery of power destroys much of the attractiveness of such a system. Considerable portions of the plant could not be thrown off without destroying the conditions.

There is no method of transformation for direct currents which would not involve the commutator difficulty. It is evident that we must look to alternating currents as a means of transmission at high potentials.

For large transmissions it is evident that the system adopted should permit the construction of dynamos of as large capacity as 1,000 h. p., so as not to multiply machines to too great an extent. It is also requisite that the construction be such that parts are readily accessible and easy to repair in case of accident.

In the employment of alternating currents we have choice of various ways of working.

It is probably not easily practicable to construct alternating dynamos or motors to make use of currents at over 3,000 or 4,000 volts without transformation. It would appear, then, that if the distance is great enough to compel the use of currents at higher pressures than 3,000 or 4,000 volts, transformation will become necessary; in which case the voltage of the generating dynamos and of the receiving machines can be as low as desired.

But the interposition of a set of transformers for raising the potential at the generator end and another set for lowering it at the receiving end, is an added expense for plant which must be balanced against saving of cost of construction of the machines and line. The percentage of loss involved in the use of transformers, due to losses incurred in the transformation, is not necessarily so great as to be serious. It can probably be brought down to about five to six per cent. under full load for the double transformation.

In the transmission of power by such a method the losses, then, are those of the line, the double transformation and the dynamos and motors. The total loss need not exceed 25 per cent. under full load condition.

If the transmission is for lighting, and the transformation down at the receiving end is made to give the voltage required for the lamps, the motor losses would be supplanted by losses on the local mains or local distribution. If motors be run from such lines the losses are of course increased by the drop in reaching them, depending on their distance from the transformers which feed current to them. It will sometimes be found practically impossible to transform down directly to lamp potential from the high potential of transmission. This is the case when it is not permissible to carry the high potential lines to transformers placed here and there in a city. In such cases an intermediate transformation may be resorted to, but it, of course, involves a greater cost of plant and another three per cent. loss or thereabouts. Dear fuel and very abundant water power may sometimes warrant such procedures.

In all such cases of cumulative drop, difficulties arise from the fall of potential under load, and adjusting devices at the transformers or on the lines may require to be employed.

Fortunately variations in the voltage may, with alternating currents, be effected by the use of variable reactive coils instead of resistances, and regulation may be obtained with fair economy. As regards the single phase alternating currents, involving the use of but two lines, which is the system commonly used, nothing more is required for such work as lighting, and it is to be hoped that self-starting effective motors may be forthcoming for use on such systems. Progress has certainly been made toward securing such motors, and a year or two hence we may find many in active service on existing lines.

For power transmission a reversed alternating dynamo, if of a good type, is also a good motor when brought to synchronism, and it has the advantage of maintaining a speed as regular and constant as the speed of the generators at the other end of the line, but it has also the serious disadvantage of requiring to be brought up to full speed before it will work at all. It is essentially non-starting. Too much complication is introduced into the plant by the introduction of elaborate devices for starting. It has been proposed to start such motors by connection with a small, not necessarily very efficient motor of the self-starting variety, of which there are several quite suitable for the purpose, working by alternating currents of single phase.

Where the power is to be delivered en masse at a receiving station, it is possible that such methods of working may become important. Alternating dynamos are now constructed which, when even of moderate capacity, have a commercial efficiency of considerably over 90 per cent, and therefore approach, if not equal, the best types of continuous current apparatus. These machines reversed and used as motors may be expected to have an efficiency equal to their rendering as dynamos, and are easily made self-exciting.

Great interest has recently been excited from the use of the three-phase alternating current, or rotary current, in the Lauffen-Frankfort transmission. This experiment, covering a distance of over a hundred miles, was successful so far as the technical matters involved were concerned. It was not intended as an exemplification of a commercial transmission. It served its purpose in proving the possibility of working with alternating current of very high potentials, and also showed in a striking manner certain features of the multiphase system.

Let us assume that we have a station in which the dynamos are excited by a continuous current, and that the armatures are provided with a three-branched conductor, similar to a Thomson-Houston arc machine, but with three cell collector rings instead of the three commutator segments, three separate brushes bearing on the rings. Or, if the field of the dynamo revolves, the connections are made directly to the stationary armature coils. The three wires may, in other cases, be connected to points in a continuous or Pacinotti winding, such that they are virtually taken at 120 degrees apart in a bi-polar machine, 60 degrees in a four pole, etc. In such cases we will have three lines leading from the generators, in which lines alternating currents may flow with the waves displaced relatively 120 degrees, or in which, when any one current wave is at its maximum, the two others are nearly at their mean value, one rising and the other falling. This has been called a "rotary current" abroad, but it is no more rotary than any current is. In fact, it is no more rotary, as a current, than is steam which is fed by three steam pipes to three cylinders of an engine, in which the cranks are set 120 degrees apart around the shaft. It is true that such currents are capable of producing a rotary magnetic field, just as is a two-phase system, but a rotary field is also produced by the rotation of a set of brushes around a commutator attached to an armature of the ordinary continuous current type, such a current being passed in by the brushes.

By the use of transformers the three-phase alternating currents can be transformed up or down as with a single-phase current. Specially constructed transformers permit a combination of the magnetic circuits of such transformers in a manner to form as it were a triplicate transformer, having certain advantages which will not here be dealt with. It is evident, however, that the advantages of high potential transmission may be obtained in this system by transformation, while low or moderate potentials may exist at the dynamos and motors.

In the reconversion of energy of three-phase currents back into power we have choice of two types of motor: first, the reversed three-phase generator which synchronizes in speed perfectly with the generator; second, the three-phase non-synchronous motor which changes in speed or requires regulation for difference of load.

The former requires its field magnets to be excited with continuous currents and will not necessarily start itself. It will, however, start along with the generator while the latter is starting, if the fields of both be excited strongly and no great load be on the motor machine.

The machine is simply a three-phase dynamo reversed, current being delivered to the three connections of the three-branched armature conductor and the field excited continuously as in the dynamo.

The non-synchronous type of motor becomes, by proper proportioning, practically capable of maintaining a speed which does not vary over a few per cent. from light to full load; it requires no exciting current and starts under load. In construction it is simply a structure in which the rotating field, set up by three currents of a three-branched or suitably arranged conductor in a laminated iron mass called the field, drags around a movable armature carrying a system of closed conductors in which strong currents are set up by the moving lines from the field, which acts to close its magnetic circuit through the armature iron. Thus the rotating bundles of magnetic lines in cutting the armature conductor push such conductor along by virtue of the reaction of the opposing currents set up in the armature conductors or closed circuit. Such motors, not being reversed dynamos, cannot act to generate current if revolved by power. Their great advantage is that they may be placed anywhere where convenient to receive current from the mains direct or from transformers, they may be started or stopped at will and have no commutators. That they may be made quite efficient is evident; that is only a question of proper designing. Both forms of motors mentioned for three-phase currents will doubtless have their uses. While lights may be run from three-phase current systems by transformers, or directly from the mains if the potential be proper, such systems possess no peculiar advantages over the single phase systems except that in the generation of three-phase currents a smoother action of the dynamo is obtained and probably therefore a slightly increased economy, or perhaps a little greater output.

There is another important way in which the three-phase currents may be utilized at the receiving end. They may readily be transformed into continuous currents of low potential, or of any potential practicable for commutation. The means for transformation in this case is a motor generator of special construction. It possesses an armature winding and connections suitable for three-phase currents, a field magnet system excited by continuous currents from any suitable source and acting on the armature, a secondary winding on the armature, or the same winding as that connected to the three-phase mains, with the usual numerous connections to the segments of a continuous current commutator, upon which brushes suitably adjusted take off continuous currents. These may be used for lighting, for running continuous current motors, etc. Motor generators giving 500 volts continuous current, 220 volts and 110 volts are easily worked from the same system of three-phase mains. The excitation of these machines may be obtained from their own commuted currents; they are self-propelling after having been started along with the generating plant, or may easily be brought to speed before connecting with the three-phase supply by continuous current from another machine in work. They can be compounded for drop of potential in themselves and the lines leading to and from them.

The future supply of electricity in a large city for all purposes, at any desired voltage of continuous or alternating current, would seem to involve a system about as follows:

A generating station conveniently located for obtaining water for condensing, cheap fuel delivery and ready disposal of ashes, containing huge triple compound condensing engines driving large dynamos, delivering either directly or through transformation upward high potential three-phase currents; a system of high potential mains for three-phase currents, probably consisting of sets of three conductors with a heavy open braid or network covering, tightly woven on, and drawn into an iron pipe filled with insulating oil placed underground to avoid atmospheric disturbances; sub-stations containing compounded three-phase motors, generators feeding into the street mains at the desired potential for lights and continuous current motors; motor generators feeding currents of suitable potential for street car propulsion; alternating current transformers delivering currents of alternating character at desired voltage for lighting and for driving commutator-less three-phase motors.

There is no electrical service which could not receive its supply from such a system. The time is perhaps not quite ripe for such a comprehensive scheme, but its advantages are obvious to those familiar with the present conditions of supply in large cities.

Time has not permitted the extension of this paper to cover matters of detail, however interesting, and an attempt has simply been made to review in a brief manner the salient points of several systems involving high potential transmission.

The purpose of the paper has not been to present any of the history of the growth or development of these various systems touched upon, nor to enter into any of the refinements of theory or practice with such systems, a proper consideration of which question would be very lengthy and consume more time than is at our disposal.

The question may be asked, what are the highest potentials which can ever be made available in electric transmission. Any answer given will necessarily imply foretelling the future practice, a very hazardous thing to attempt. Such answer may, however, be taken to relate to either a single phase alternating system or a multiphase, the only difference being in the number of conductors employed. In fact, it is conceivable that the number of conductors in a single phase system be reduced to one central conductor surrounded by a tube or by several conductors, all inclosed and insulated from a surrounding pipe. Let the pipe be filled with oil and the conductors be separated by being wound with an absorbent net of dry cotton, and let the covering of oil extend over the conductors and be unbroken, practically, over the whole of the high potential conductor, including the fine coils of the transformers at each end of the line, and we have a system in which the employment of very high potentials may become quite feasible. If we provide in the thickness of our oil insulation a sufficient margin of safety from puncture, and so calculate our line that its self-induction and capacity compensate for one another's effects, it would seem that there would be no difficulty from leakage, or from Ferranti effects, as they are called. The condenser effect of the Ferranti cables is large while the self-inductive effects are small. Condenser action tends to accelerate the phase at the dynamo and self-induction retards or lags the phase of the currents and it would seem that by distributing the capacities and self-inductions properly the normal phase without either acceleration or lag could be maintained.

A layer of good insulating oil one inch thick between rounded smooth metal surfaces will equal in resistance to puncturing a potential which will cause a spark in air over 30 inches long. At least the author's tests on this subject point to an approximate relation of 1 to 35 or 40 in dielectric strength between air and good heavy paraffine oil. As nearly as can be estimated, a spark between rounded surfaces at 30 inches in air represents not less than 500,000 volts, and the author's experiments go to show that such potentials can be "kept down," so to speak, in a bath of oil. Whether the condenser effects of a long line would introduce serious difficulties it is impossible to say, but provided that the rate of alternation or periodicity be kept low, and the insulation maintained by covering every inch of the high pressure conductors in, say two inches thick of oil, it might even be possible to work with 500,000 volts. Allowing a loss of only 10 per cent., or 50,000 volts, with a double conductor conveying 200 ampères, each conductor having about one-twelfth of a square inch section, a distance of about 240 miles would be covered, and the energy carried would be 100,000,000 watts, or over 130,000 h. p. These are striking figures, and are given by way of illustration. They may never be needed to be used in practice, yet the difficulties of realization are less than at first appears; the condenser action of the line being the most serious matter to be dealt with. Such a line is even safer, so far as life risks are concerned, than an overhead line of much less pressure. In fact, it may be said to be practically safe. Any interference with the line is difficult on account of the pipe inclosing it, and on the first weakening of the insulation, or before a break in the pipe became complete, a short circuit of a moderate current would take place, and the fuses be blown at the ends of the line. Pipe lines are laid for the conveyance of oil; why should they not be laid for the conveyance of electric energy where it can be done economically? Looked at from the standpoint of very high potentials, Niagara may be said to be gradually approaching the surrounding cities.

A Regulator for the Arc Light.

BY W. C. PECKHAM.

For a year and more past I have been using upon the arc lamp in my lantern a device, or regulator, to hold the arc in a fixed position in the front of the carbons, which works very successfully. It will benefit others who have been troubled by the swinging of the arc around the carbons, the "blinking" of the lamp often entirely obscuring the illustration on the screen.

The illustration shows the lamp with regulator in position. It is in series with the lamp, and the whole current flows through it. It is secured in the same plane with the focus of the condenser and the axis of the lenses. The regulator is attached to the base of the lamp, and does not move when the carbons are adjusted to focus, as they burn down.

The device consists of an electromagnet, wound with a few turns of No. 12 insulated copper wire, just enough to furnish the requisite repulsive force upon the arc. The cores project about one and a half inches beyond the coils, so that these are set back beyond the great heat of the arc, which would destroy their insulation. An asbestos covering would still further protect them, if necessary.

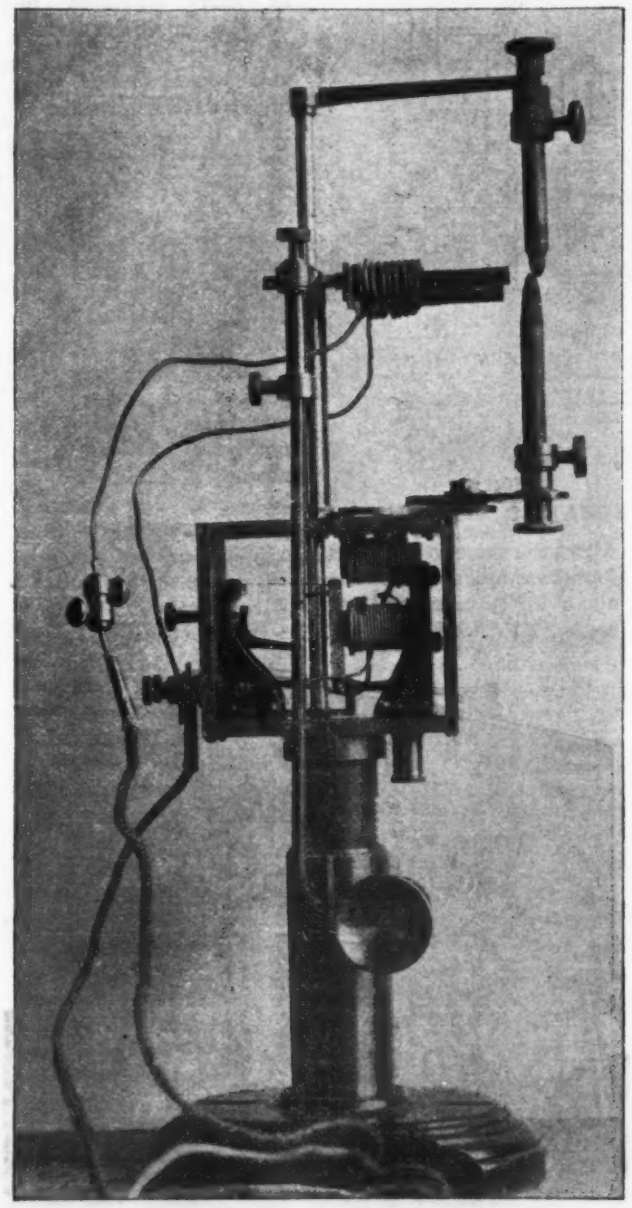
The wires are connected so that both poles drive the arc toward the farther, or front, side of the carbons, and it will not approach nearer to the poles of the magnet, of course. The fact of this repulsion of the arc by a magnet pole is not a new discovery, nor is its use for certain purposes. This application of the fact is believed to be new. Wherever it is desirable to hold the arc in a definite position this regulator has value. It can easily be attached to any form of lamp, focusing or search light.

Statistics of Electric Lighting in Massachusetts.

The seventh annual report of the Board of Gas and Electric Light Commissioners of Massachusetts for the year ending June 30, 1891, which has just been issued, contains a large amount of information in regard to electric lighting in that State. The report shows that there were 131 companies under the supervision of the board, 26 of which supply both gas and electric light, 58 only electric light, the balance only gas. During the year only two new companies were incorporated. The total results of the year's operation of the electric light central stations, compared with the year 1890, were as follows:

	Year Ending June 30, 1890.	1891.
Receipts:		
For light and power	$1,908,394.90	$2,432,869.15
From other sources	12,308.05	7,481.50
	$1,920,702.05	$2,440,350.65
Expenses:		
For manufacture	$752,831.18	$1,014,242.88
" distribution	281,046.33	356,332.38
" office expen. and management.	116,350.92	159,230.90
" taxes	67,620.91	82,743.77
" miscellaneous	122,965.26	122,656.20
	$1,340,814.60	$1,735,206.13
Leaving a balance of	579,887.45	705,144.52

These figures show the earnings of electric light companies and of the electric light departments of gas companies.



PECKHAM'S REGULATOR FOR USE ON ARC LAMPS IN PROJECTORS.

The amount of net earnings of the electric light departments of gas companies was $110,871.40 in 1890. For 1891, $143,240.78, showing an increase of $32,369.38 during the past year. The net earnings of the electric companies in 1890, $469,016.05. In 1891 they were $561,903.74, showing an increase for 1891 of $92,887.69. The total capitalization of companies in active operation at the end of the year was $5,866,300. The total number of stockholders of the electric light companies was 2,435, and of this number 2,062 were residents of Massachusetts. In the number of stockholders the Boston Electric Light Company leads the list with 406, while the Lowell Electric Light Company has 358. In capitalization the Edison Electric Illuminating Company, of Boston, heads the list with $1,263,500, this stock being held by 78 stockholders, of whom 69 reside in Massachusetts. The total valuation of the electric plants as shown by the local assessors was $2,035,160. Fifty-four companies had notes and bonds outstanding to the amount of $3,204,567.48. Dividends were paid by 25 companies, amounting to $262,968. These ranged from a 10 per cent. dividend in the case of the North Attleborough Electric Light Company to one of one per cent. paid by the Westborough company.

The five and a half per cent. dividend of the Edison Illuminating Company, of Boston, was the largest paid of any company, amounting to $63,800. The largest arc light company in the State is the Boston Electric Light Company, with 2,401 arc lights of 2,000 c. p., besides 6,160 incandescents of 16 c. p. The Edison company, of Boston, leads in incandescent lighting with 44,761 incandescents of 16 c. p., supplied from 64 dynamos.

The total number of boilers in use in central stations was 216. These furnished steam to 261 engines. The total number of dynamos in use was 591. Two plants use water power exclusively and three others use both water and steam power. The returns for fuel consumption show that the greatest amount of coal burned was in the stations of the Boston Electric Light Company, amounting to 18,295 tons, the Boston Edison company coming next with 12,000 tons. One plant is operated with three 15 h. p. gas engines, the consumption of gas being 1,203,000 feet. This plant has a capacity of 69 arc lights, of 1,200 c. p. each. One plant bought its steam, and in one the power was leased.

The following table shows the number of electric lights of various candle power represented by the dynamo capacity, June 30, 1889, 1890 and 1891:

	1889.	1890.	1891.
16 c. p.	80,075	140,870	181,270
20 "	2,800	1,700	8,530
15 "	880	880	836
2,000 "	6,978	8,425	8,401
1,200 "	4,206	6,085	6,447
1,600 "	130	60	160
1,500 "	35	60	60
1,850 "	40	40	200
800 "	140	70	70

The number of public gas lamps supplied by the companies showed a decrease of 1,384. The total number of gas meters in the State is 110,778.

Five persons were injured during the year by electricity, one of them fatally. Thirty persons were injured by illuminating gas, 16 of them fatally. Of the latter two committed suicide. The total number of deaths caused by inhaling illuminating gas in the United States during the year 1891, as reported to the board from various sources, was 211. In the reports thus given, it appears that of this number 33 were cases of suicide and 178 are supposed to have been accidental.

The increasing use of meters has called attention to the possible necessity for a new basis for charges for incandescent electric lighting service. With many companies the difference between average and maximum load is very great, and the largest demand lasts but a short time.

Until some method of storing electric energy in quantities which shall have greater commercial value than any now upon the market is devised, both the generating and distributing plant of a company must be capable of maintaining a satisfactory standard of light at the time of maximum load.

Proceedings have been begun in the Supreme Judicial Court by the attorney-general against the Walworth Light and Power Company to compel the removal of numerous wires, running over streets in the central portion of the city of Boston, and used for the supply of electric lights.

These wires were erected and maintained without permission from the city, and in the face of a formal rejection by the aldermen of the petition of the company asking leave to construct and maintain them.

The company has admitted the existence and use of the wires, but contends that there was no violation of the statute.

Notices have been sent to the attorney-general in compliance with the statutes, of the alleged violation of the laws by the Electric Light and Patent Flooring Company, of Amesbury; Framingham Electric Company, Milford Electric Light and Power Company, Nantucket Electric Light Company, and the Suburban Light and Power Company, of Boston, in not making returns to the board, as required by law.

The Gardner Electric Light Company has succeeded to the business and property of the Gardner Electric Company, paying therefor the amount of the mortgage notes of the latter and assuming its debts.

The property and franchises of the Miller's River Gas Light Company were sold by the mortgagees under foreclosure and the purchasers have been incorporated as the Athol Gas and Electric Company.

A similar course was pursued by the mortgagees of the Stoughton Light, Heat and Power Company, incorporated under the laws of Maine, and the purchasers have become a Massachusetts corporation under the name of the Stoughton Gas and Electric Company.

A consolidation of the two companies in Middleborough has been effected by the purchase of the Middleborough Electric Light and Power Company by the Middleborough Gas and Electric Company.

The board has endeavored, by the means at its command, to ascertain what action has been taken throughout the Commonwealth in respect to the business contemplated by the municipal ownership law, which was approved June 4, 1891, it being chapter 370 of the acts of 1891, entitled "An act to enable cities and towns to manufacture and distribute gas and electricity." There are 210 towns and cities in the State with a population of 1,500 or more, and official information has been received from 205 of these. It appears that 180 towns have taken no action.

Of the various systems in use in the State the following are noted: Thomson-Houston, Westinghouse, Brush, Schuyler, American, Ball, Waterhouse, Sun, Weston, Electro-Dynamic Company, Arnoux Hochhausen and Edison Municipal. Of these the Thomson-Houston was used by 69 electric lighting companies, the Westinghouse by 13, the Edison by 10, the Schuyler and American each by 6, the Waterhouse and Brush each by 5, the Ball

by 3, the Edison Municipal by 2 and the Electro-Dynamic, Sun, Weston and Arnoux Hochhausen each by 1.

The total length of wire in feet in use in the State was 24,632,523; the length of underground conduit in feet, 219,580; length of wire in conduit in feet, 716,187.

Measurement of the Lag Between Two Alternating Currents.

BY OTTO HOLZ.

In the increasing application of alternating currents for power, it is of great importance to know the exact angle of lag between different circuits, as in the multiphase motor, or to ascertain its absence, as in the Stanley motor. A direct measurement of the actual lag is without doubt preferable to calculating it. Mr. Blakesley has shown that the lag of two currents, measured by the use of three dynamometers, can be found by the formula

$$\cos\theta = \frac{a_3}{\sqrt{a_1\, a^2}},$$

where a_1 is the reading when the instrument is traversed by one current alone, a_2 if traversed by the other alone,

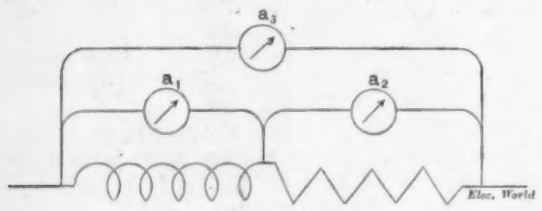


Fig. 2.

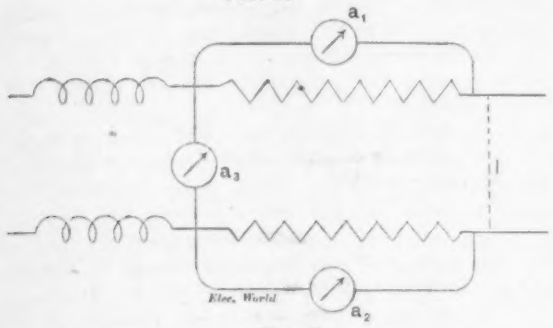


Fig. 3.

MEASUREMENT OF LAG BETWEEN TWO ALTERNATING CURRENTS.

and a_3 the reading when one current is going through the fixed coil and the second through the movable coil.

This method has the disadvantage of swinging three dynamometers, as the instruments must be left in the circuit during the test on account of their self-induction.

Profs. Ayrton and Sumpner have measured the lag between the current and P. D. of one circuit by the use of only one voltmeter, taking three readings:

If a_1 is the P. D. of the inductive and a_2 that of a non-inductive circuit, they can be compounded after the well-known parallelogram of forces, Fig. 1.

If both P. Ds. are put in series, their sum is represented in magnitude and direction by the diagonal a_3. By trigonometry we get

$$\cos\theta s = \frac{a_1^2 + a_2^2 - a_3^2}{2a_1\, a_2}$$

But θ, being the supplement of θs, has its cosine equal in magnitude, but opposite in sign to $\cos\theta s$:

$$\cos\theta = \frac{a_3^2 - a_1^2 - a_2^2}{2a_1\, a_2}$$

The writer proposes to extend this method to the measurement of the lag of two or more currents, which are independent of each other, each having its own circuit, as is the case with motors, in the following manner:

Two non-inductive resistances are put in series with the magnetizing circuits, as shown by Fig. 3. Their P. Ds. are measured first separately, then after connecting two ends by a wire l, and the other two through the voltmeter, the third reading is taken, which shows the P. Ds. of both non-inductive circuits in series. Therefore the same formula—

$$\cos\theta = \frac{a_3^2 - a_1^2 - a_2^2}{2a_1\, a_2}$$

will hold good, where a_1 is the reading of one circuit, a_2 of the other and a_3 of both in series. It is evident from Fig. 1 that there is no lag, when the sum of a_1 and a_2 equals algebraically a_3.

An analogous use of three ampèremeter readings, (Fig. 4) makes three ampèremeters necessary on account of their self-induction, but it does not necessitate the raising of the E. M. F. of the generator, lest the current be diminished by the additional non-inductive resistance.

We have yet to consider that the magnetization lags behind the magnetomotive force (Fig. 5) and if the magnetic circuits, around which the currents are flowing, differ, the lag between the magnetizations is not represented by the lag between the currents. It is therefore preferable to place fine wire coil in inductive relation to the magnetic circuits, for as the P. D. of each fine wire coil lags exactly 90 degrees behind the magnetization, their angle of lag is not altered and represents the lag between the actual magnetizations.

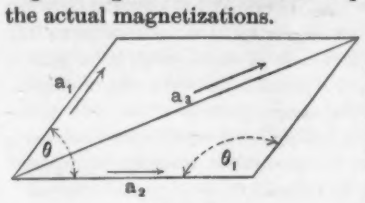


Fig. 1.

The fine wire coil is closed only through the high resistance of the voltmeter and does not allow enough current to flow as will introduce a perceptible error by diminishing the counter E. M. F. of self-induction of the magnetic circuit. In this case the E. M. F. of the generator need not be raised.

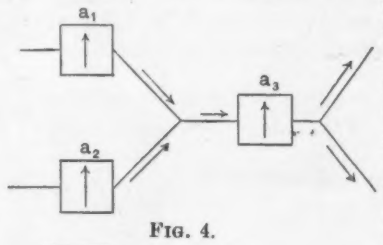


Fig. 4.

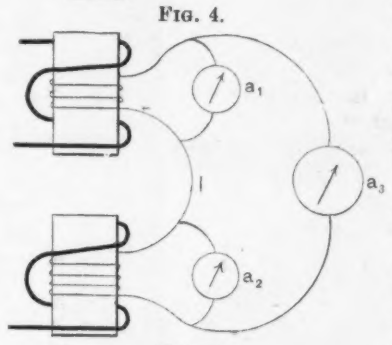
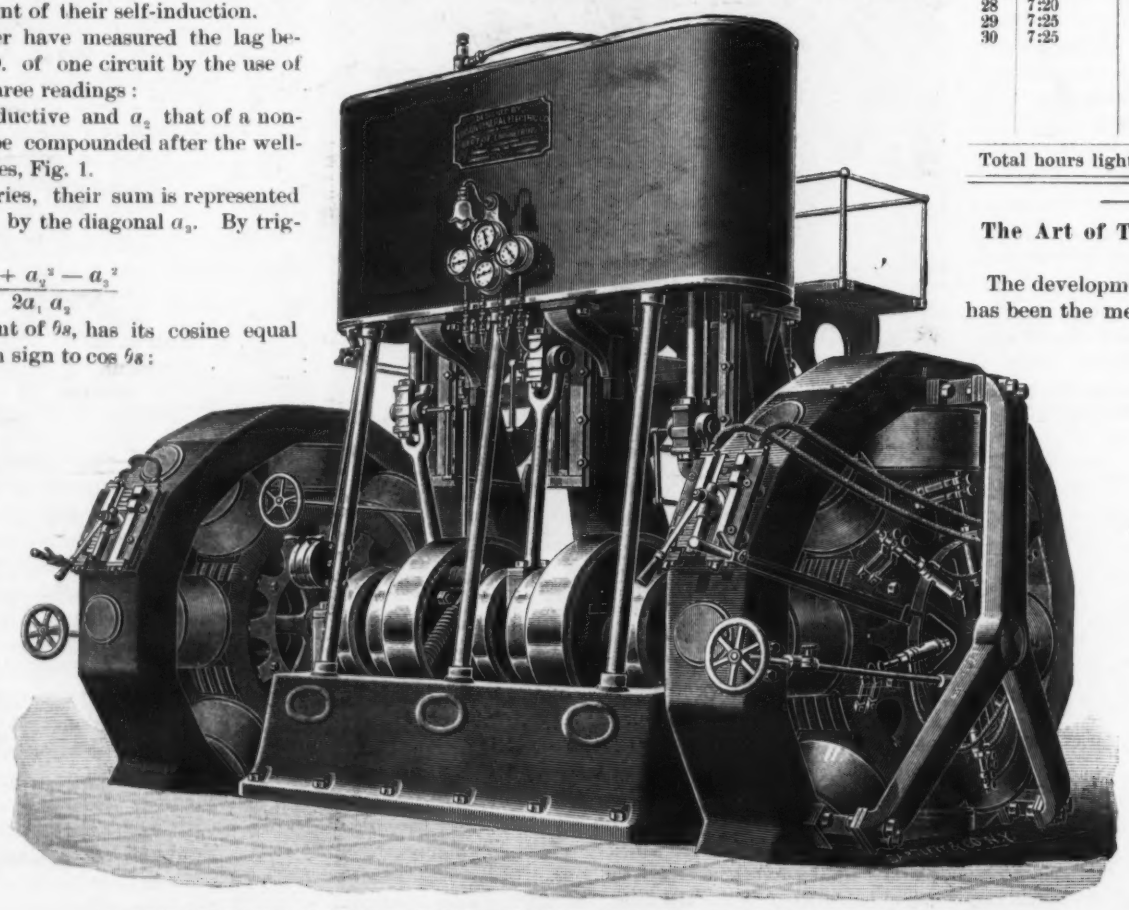


Fig. 5.

Edison Triple Expansion Engine and Multipolar Generators.

The tendency of modern central station practice is to increase the size of individual units wherever possible, and indeed this has in many instances been a matter of almost absolute necessity. In many situations in large cities where central stations are to be built the value of real estate is very high and the question of taxes becomes an important one. The use of compound and triple expansion engines coupled directly to slow speed mutipolar dynamos in stations of this kind has therefore become a necessity wherever economical operation is desired.

Vertical high speed engines coupled direct to multipolar dynamos are not new in electrical engineering practice, as they have been used for many years in plants on shipboard where the space to be occupied is limited, and in the many foreign central stations where it has been the practice to aim at higher economy than has been usual with American engineers. The building of the Edison triple expansion engine connected direct to multipolar generators, an illustration of which is shown on this page, is, however, the first attempt in American practice to introduce on a large scale this style of apparatus into American central stations. Multipolar generators are used in which the armature is of the Gramme ring type built up of shaped copper strips which are slipped in a single layer over the laminated wrought iron core, the upper end of one being connected with the lower end of the adjoining loop by a copper bar of corresponding thickness, these bars acting as the segments of the commutator. The number of brushes corresponds to the number of poles of the generator, and it is claimed that the large current output can be divided among these brushes much more conveniently than if only one set of brushes were used to carry the whole current generated. The arrangement for controlling the brushes allows of their being operated together so that when once adjusted they can all be handled together as if only one set were used.



EDISON TRIPLE EXPANSION ENGINE AND MULTIPOLAR GENERATORS.

The field coils are wound on separate spools and these are slipped over the field magnet cores. These cores are then inserted in an annular or polygonal field frame, this latter being mounted on the bed plate of the engine.

The Edison company has begun the manufacture of central station engines of this type consisting of two multipolar dynamos coupled direct to a triple expansion engine, which range in capacity from 50 to 800 h. p. The practice is to connect a generator to each side of the engine as shown in the illustration. The armatures are mounted directly on both ends of the crank shaft and act as substitutes for the flywheels of the engine.

The engines employed are of the marine triple expansion automatic inverted cylinder type. They are well proportioned, and it has been the aim of the designers to embody in them the latest improvements resulting from the best practice of both this country and Europe. The governor is said to operate well within the requirements of dynamo regulation. The parts are easy of access, as convenience of operation has been carefully studied.

Moonlight Tables for April, 1892.

Herewith we give Mr. H. W. Frund's table of lighting hours for the month of April, under his modified form of moon schedule:

TABLE NO. 1. Standard Moonlight, Philadelphia System.				TABLE NO. 2. Frund's New Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	6:55 P. M.	2	4:40 A. M.	1	6:55 P. M.	2	4:40 A. M.
2	12:00 M.	3	4:40	2	6:55	3	4:40
3				3	6:55	3	12:00 M.
4	12:55 A. M.	4	4:40	4	12:55 A. M.	4	4:40 A. M.
5	1:45	5	4:35	4	7:00 P. M.	4	12:00 M.
6	2:22	6	4:35	5	1:45 A. M.	5	4:35 A. M.
7	2:55	7	4:35	5	7:00 P. M.	5	12:00 M.
8	3:20	8	4:30	6	2:20 A. M.	6	4:35 A. M.
9	3:40	9	4:30	6	7:00 P. M.	6	12:00 M.
10	No light.	10	No light.	7	2:55 A. M.	7	4:35 A. M.
11	No light.	11	No light.	7	7:00 P. M.	7	12:00 M.
12	No light.	12	No light.	8	3:20 A. M.	8	4:30 A. M.
13	No light.	13	No light.	8	7:00 P. M.	8	12:00 M.
14	7:10 P. M.	14	10:10 P. M.	9	7:05	9	12:00
15	7:10	15	11:15	10	7:05	10	12:00
16	7:10	17	12:15 A. M.	11	7:05	11	12:00
17	7:10	18	1:15	12	7:05	12	12:00
18	7:10	19	2:05	13	7:05	13	12:00
19	7:15	20	2:55	14	7:10	14	12:00
20	7:15	21	3:35	15	7:10	15	12:00
21	7:15	22	4:10	16	7:10	17	12:10 A. M.
22	7:15	23	4:10	17	7:10	18	1:15
23	7:15	24	4:10	18	7:10	19	2:00
24	7:20	25	4:10	19	7:15	20	2:50
25	7:20	26	4:05	20	7:15	21	3:30
26	7:20	27	4:05	21	7:15	22	4:00
27	7:20	28	4:05	22	7:15	23	4:00
28	7:20	29	4:00	23	7:15	24	4:00
29	7:25	30	4:00	24	7:20	25	4:00
30	7:25	1	4:00	25	7:20	26	4:00
				26	7:20	27	4:00
				27	7:20	28	4:00
				28	7:20	29	4:00
				29	7:25	30	4:00
				30	7:25	1	4:00
Total hours lighting, 155.45.				Total hours lighting, 217.			

The Art of Tanning Leather and Making Belting.

The development of the application and use of electricity has been the means of bringing about a consequent development in the manufacture of many of the appliances used in connection with the use of electricity. The art of tanning leather and the making of belting has come in for its share of attention, with the use of special makes of belting in central stations and electric railway plants. At the meeting of the polytechnic section of the American Institute of New York Thursday evening of last week, an interesting paper was read by Mr. Chas. A. Schieren on "The Art of Tanning Leather and Making Belting."

The various processes through which a hide passes in the tannery were illustrated by lantern slides.

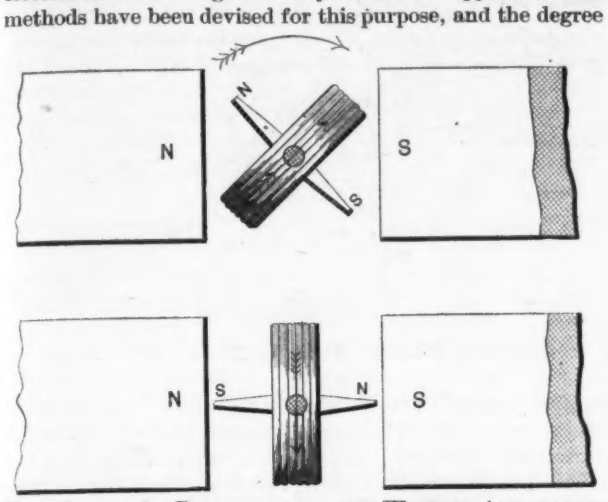
The various departments through which the hide passes in the tannery, the machinery used for manipulating the leather, as well as the grinding and leaching of the bark, were illustrated and thrown on a large canvas by the same means. This made the lecture especially interesting from the fact that the audience could gain a clearer idea of the manipulation of leather in the tannery.

In the making of belting Mr. Schieren showed a hide of leather from which were taken four pieces of equal length and width, which had been submitted to a test by a powerful testing machine of the Fairbanks Scale Company, of New York. These pieces were each eighteen inches long and two inches wide, and were numbered. Number three, being cut from the lower part of the centre, broke at 2,490 pounds strain, which would give the piece a transverse strength of 14,940 pounds per square foot. Number four, cut from the upper part of the centre of the hide, broke at 2,000 pounds. Number five, cut from the lower part of the shoulder piece, broke at 1,390 pounds. Number six, cut from the upper part of a shoulder, broke at 1,130 pounds.

Application of the Weston Voltmeters and Ammeters to Practical Electrical Measurements.—I.

BY H. MASCHKE, PH. D.

Introductory.—In no branch of modern engineering has the necessity of working under close control of accurate measurement, been felt more urgently by those connected with the art than in electrical industries, and not many of nature's forms of energy are capable of being controlled and measured with a similar degree of perfection as the electric current. A great many forms of apparatus and methods have been devised for this purpose, and the degree



FIGS. 1 AND 2.—PRINCIPLE OF THE WESTON APPARATUS.

of accuracy attained is an admirable proof of the wonderful progress of modern science.

There is, however, a great difference between the requirements of scientific work as carried out in laboratories furnished with all improvements and conveniences, and those of practical work, where the conditions of working are generally complicated by a large number of unfavorable circumstances, and where time saving is one of the most important items. It may fairly be said that, notwithstanding the astonishing amount of energy and ingenuity displayed in the invention and construction of electrical measuring instruments, almost all the forms of apparatus at present in daily use by the electrician are far from satisfying the practical requirements. In fact, the demand for improved apparatus is continually raised among electrical engineers and is constantly increasing.

It is with the view of satisfying this demand that the Weston standard voltmeter and ammeter to be described below, for measuring electromotive force and strength of current, have been designed. The general and high recognition with which these instruments have met since the day they were put into the market may be considered as a fair proof of their superiority over their competitors. They seem entitled to the claim that they answer the requirements of electrical practice more perfectly than any other instruments in use for the same purpose, especially as far as convenience, accuracy and reliability are concerned, and it has frequently been acknowledged by competent authorities that they even surpass a great many forms of apparatus especially constructed for laboratory work.

Although everybody who has ever used the instruments will readly admit the great advantages offered by them, still they might be exposed to the objection made to all instruments in which permanent magnets are applied, viz.: that the magnetism might not keep constant for any great

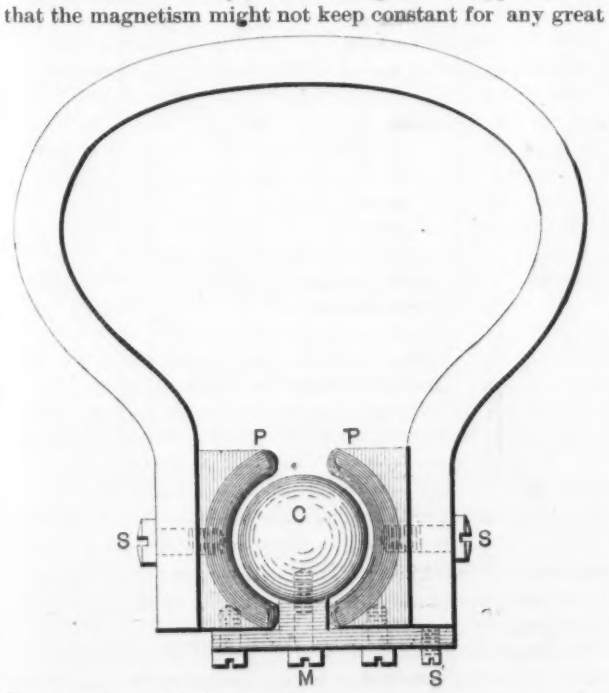


FIG. 3.—THE MAGNETIC FIELD OF THE WESTON INSTRUMENTS.

length of time. Experiments to be described below will show how perfectly groundless this prejudice is, as far as the Weston instruments are concerned. It is sufficient here to state that with instruments continually in use for three years, no change of the readings could be noticed amounting to more than one-tenth of one per cent.

The object of the following articles is to give a brief description of the Weston instruments, and to follow this with a description of some of their more important applications. The descriptions will be such as will enable even those who are not familiar with the methods of electrical measurements to use the instruments for such measurements. An experienced electrician might see for himself what may be done with the instruments for other than voltage and current measurement, but he will be interested to learn what high degree of accuracy may be reached in certain measurements with this simple apparatus, which otherwise would require very complicated arrangements.

DESCRIPTION OF INSTRUMENTS.

§ 1. *Principle of the Apparatus.*—If a flat coil of wire carrying an electric current is brought between the poles of a horseshoe magnet, it behaves exactly as if it were rigidly connected to a magnet fixed in its centre vertically to the plane of its windings. (See Fig. 1.)

Now, suppose the coil shown from above in Fig. 1 be suspended or pivoted so as to allow being rotated around its vertical axis, and let it be traversed by a current having the direction of the small arrow; it will then be turned in the direction of the larger arrow, from the position shown in Fig. 1 to that in Fig. 2. This rotation will be produced even by the smallest current, provided the coil is not acted upon by some opposing force. To make it a measuring instrument, therefore, requires that the tendency to turn be opposed by some counter force. Such a counter force is introduced in the form of two flat, horizontal, spiral springs, fastened to the ends of the coil above and below it. When no current is flowing, these springs will keep the coil in a certain zero position, from which it will be deflected the more, the stronger a current which is sent through the coil. A pointer connected with the upper end of the axle of the coil and moving over a properly graduated scale, will then indicate the position of the coil, and, therefore, the strengh of the current to be measured. This is the principle of the Weston voltmeter and ammeter.

§ 2. *The Magnetic Field.*—The magnetic field is produced by the poles of a strong steel horseshoe magnet

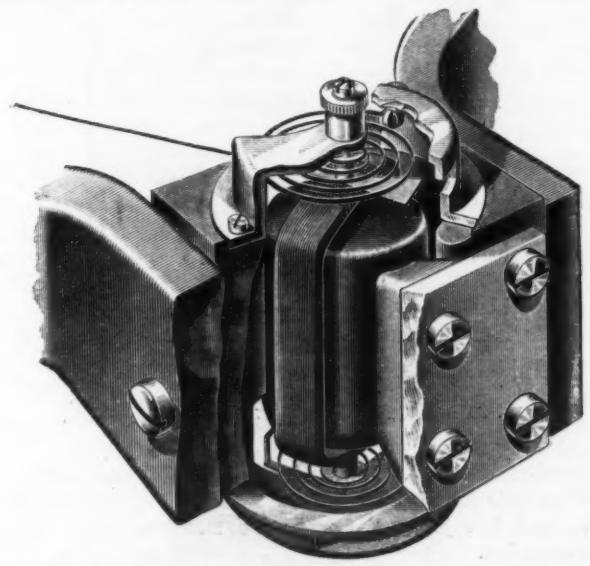


FIG. 5.—BEARINGS OF THE WESTON INSTRUMENTS.

(Fig. 3) prepared by a special process. The cross-section of the same is a rectangle of about 1.25 by 0.3 inches. Pole pieces *P P* are attached to the inner surfaces of the poles and are fastened to them by screws *S S*. The faces of these pole pieces are of such a shape as to leave a perfectly cylindrical space between them. At the front side they are connected by two screws to a brass plate *M* carrying a massive soft iron cylinder *C*, which occupies the larger part of the cylindrical space left by the pole pieces. The dimensions of this cylinder are such that a small annular space is left between the cylinder and the pole pieces, the width of which amounts to only 0.040 inch in the most recent instruments. This space represents the magnetic field in which the coil rotates.

§ 3. *The Movable Coil.*—The coil shown in Fig. 4 consists of fine insulated wire wound upon a light, rectangular frame of aluminium. To avoid any assymmetry this frame is made by a special and ingenious process from a seamless aluminium tube. Including the coil, it has a thickness of 0.015 inch, so that its distance from the soft iron cylinder *C* on the one side and the pole pieces *P P* on the other amounts to only 0.0125 inch.

Fastened to each end of the coil is a pivot of hard, polished steel, carrying a small brass collar, to which the inner end of a spiral spring is fastened. To avoid any interference from magnetic action the springs are not made of steel, but of some non-magnetic alloy. In a test made with one of these springs, it was pulled out straight, and when allowed to recoil no change could be seen.

It goes without saying that the spring is not subjected to any permanent changes through long use of the instrument. The following reasoning will dispel any doubt as to the constancy of the springs. Suppose a good watch makes about 240 beats a minute, the swing of the balance being about 360 degrees, the number of contractions and expansions of the hairspring would amount to 1,382,600 per day. If we now assume that one of the instruments is used 300 days in the year, 100 readings being made every day, the deflections extending over the full scale length, that is, about 90 degrees, it would require 46 years to do the same work with the spring of the instrument which a hairspring is doing daily. The slightest change in a hairspring would, of course, show this very distinctly during the course of a day, but we know by experience that we can rely upon a watch to a certainty for a much longer period.

§ 4. *Bearings of the Coil. Path of the Current.*—Circular grooves are cut into the pole pieces on their upper and lower surface, concentric with the cylindrical opening. Fitted into these grooves are the circular edges of two brass caps, as shown in Fig. 5, each of which carries in its centre a small sapphire forming the bearings for the pivots of the coil. By this arrangement the axle of the coil is made to accurately coincide with the axis of the soft iron cylinder.

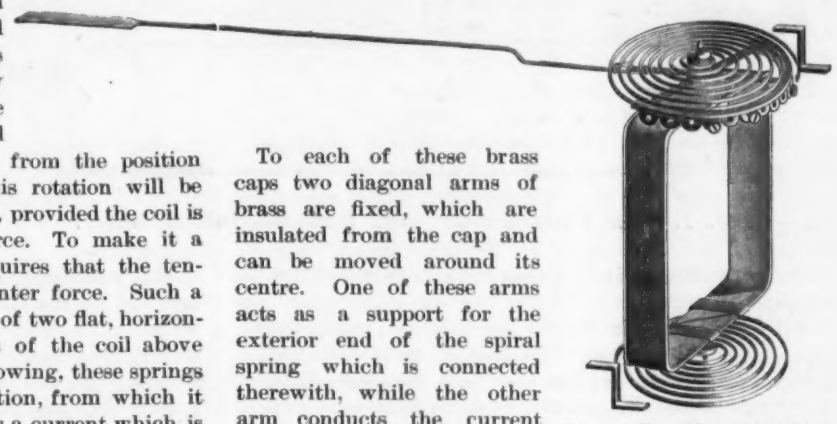


FIG. 4.—THE MOVABLE COIL.

To each of these brass caps two diagonal arms of brass are fixed, which are insulated from the cap and can be moved around its centre. One of these arms acts as a support for the exterior end of the spiral spring which is connected therewith, while the other arm conducts the current to or from the respective spring. The current therefore passes from the lower brass arm to the lower spiral spring, thence through the coil to the upper spiral spring and to the brass arm connected with the upper cap.

Most of the voltmeters contain, besides the movable coil, a separate resistance coil located underneath the scale plate (see Fig. 6) and electrically connected between one of the brass arms and one of the outside binding posts. In the ammeters the brass arms are connected directly with the terminals of a shunt contained within the instrument.

Owing to the very great care used in the construction of the bearings, which are made with the same care and precision as in the best watches, friction is reduced to a minimum. To prevent the turns of the spiral spring from being pushed up beyond the end of the brass arm by an accidental violent motion of the apparatus, the arm is prolonged slightly in a horizontal direction beyond the point where the spring is fastened. A slit is cut into the cover, through which the spring can be seen, so as to make sure that all its turns are in one plane.

§ 5. *The Scale and Pointer.*—The pointer of the apparatus is fixed to a small brass cross attached to the upper point near the bearing (see Fig. 7). The arms of the cross, by which the pointer is counterbalanced, are joined by a brass arc into which a number of minute screws are inserted for making the fine adjustment to insure accurate balancing. The pointer is made of aluminium and is flattened at its end.

When the coil is in the zero position, the pointer, whose normal direction is perpendicular to the plane of windings of the coil, forms an angle of 45 degrees with the middle line of the instrument. With the strongest current which is allowed to pass through the instrument, the pointer is deflected 90 degrees from its zero position. Beyond these

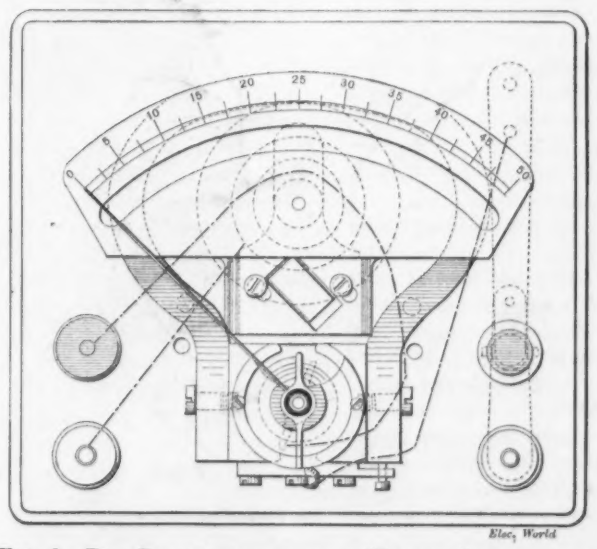


FIG. 6.—THE CONNECTIONS OF THE WESTON INSTRUMENTS.

two extreme positions the coil is allowed only a small range, its motion being stopped by the two screws by which the iron core *C* is attached to the brass plate *M*.

The scale is fastened to a brass plate, which is secured to the pole pieces, projecting from them at right angles. Below the scale, quite close to it, a mirror is attached, to enable one to avoid making an error in the reading, due to parallax.

A slight raising or lowering of the scale may be effected by loosening one of the two screws S_1 (Fig. 3) and by tightening the other one (in the figure only the upper one of the two screws can be seen). These screws do not enter into the poles of the magnet, but only press against them

The whole apparatus is mounted on a wooden baseboard and is covered with a brass case in which there are openings, provided with glass, enabling the scale and the point of the pointer to be seen.

§ 6. *Transportability.*—For transportation it is placed in a wooden box or leather case, and may be carried in any position. Shaking or knocking, if not too violent, does not hurt the apparatus. Careful adjustment or leveling is not required, it being sufficient to place the instrument approximately horizontal. Owing to this fact the apparatus is especially well adapted for use in street cars and on board ships. Violent shocks, though they will not change the magnetism of the magnet, might damage the pivots of the coil and thereby introduce the element of friction which is avoided with such care in the construction of the apparatus.

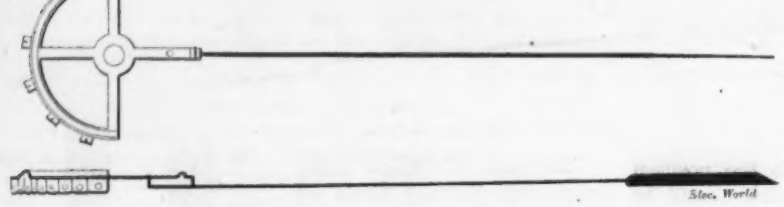


FIG. 7.—THE POINTER OF THE WESTON INSTRUMENT.

FIG. 8.—THE STANDARD SCALE, FULL SIZE.

§ 7. *Readings.*—The readings may be made immediately on applying the current. The pointer assumes its proper position by an instantaneous and dead beat deflection. It indicates also the slightest momentary or permanent variations in the current or electromotive force. The dead beat quality is due entirely to the damping effect which the frame of the coil experiences in moving through the strong magnetic field, the effect of friction in the bearings being practically naught owing to their careful construction and adjustment.

One of the most valuable features of the instrument is the uniformity of the scale (see Fig. 8). All scale readings begin at zero and it is hardly possible to discover, with the naked eye, any difference in the spacing of any two neighboring divisions. Each individual instrument is carefully calibrated for a large number of readings, and the scale drawn according to these calibrated readings. The divisions are drawn with extreme accuracy and checked subsequently with the indications of a standard instrument.

Owing to the uniformity of the scale divisions, the fractions of a scale division may be estimated with great precision. As one-tenth of a scale division can be estimated easily, an apparatus ranging from 0 to 150 volts will allow reading to one-tenth of a volt. With the double scale voltmeters, the lower scale of which ranges from 0 to 5 volts, one three-hundredth of a volt may be read; and with the millivoltmeters, the range of which extends from 0 to 0.01 volt on a scale divided into 100 divisions, readings may be taken which are accurate to one hundred-thousandth of a volt. The same degree of accuracy is attained in the ammeters.

§ 8. *Hysteresis.*—In a great many other instruments containing soft iron, especially if the iron is in their movable parts, the indications obtained for the same amount of current are different, depending on whether the current was

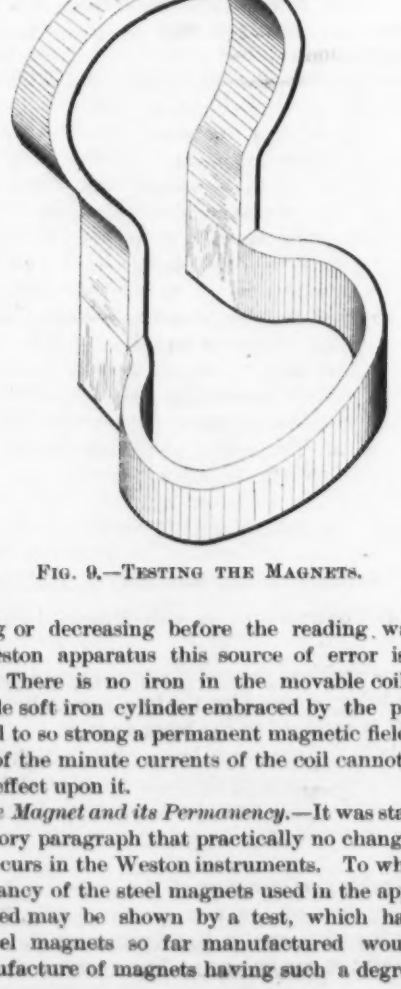


FIG. 9.—TESTING THE MAGNETS.

increasing or decreasing before the reading was taken. In the Weston apparatus this source of error is entirely avoided. There is no iron in the movable coil, and the immovable soft iron cylinder embraced by the pole pieces is exposed to so strong a permanent magnetic field that the reaction of the minute currents of the coil cannot have the slightest effect upon it.

§ 9. *The Magnet and its Permanency.*—It was stated in the introductory paragraph that practically no change of magnetism occurs in the Weston instruments. To what degree the constancy of the steel magnets used in the apparatus is maintained may be shown by a test, which hardly any other steel magnets so far manufactured would stand. The manufacture of magnets having such a degree of permanency, means an important progress in practical electrotechnics.

The following experiment will therefore be of interest not only as far as these instruments are concerned, but because it is a matter of general interest: The cover of a voltmeter was removed and the terminals connected with a circuit of the highest voltage allowable for that instrument, the pointer standing exactly over the 150th scale division. A magnet taken from another similar voltmeter was then placed vertically upon the poles of the magnet of the instrument, as shown in Fig. 9, the north pole of the one magnet being placed on the south pole of the other. The deflection of the pointer immediately went back to division 25. The top of the vertical magnet was then struck repeatedly with the wooden handle of some tool, as hard as the solidity of the apparatus would allow, which, as is well known, is about the best means of destroying the constancy of the power of a magnet. Notwithstanding this, upon removing the vertical magnet, the pointer immediately returned almost exactly to division 150. Although the experiment was repeated very often, the difference in reading caused thereby never exceeded one-half of a scale division. The same favorable result was obtained, when the vertical magnet was placed upon the horizontal one with similar poles together, and hammered as described. It may be remarked that every instrument is submitted to this test before leaving the factory and is rejected if found not to stand it with perfect satisfaction.

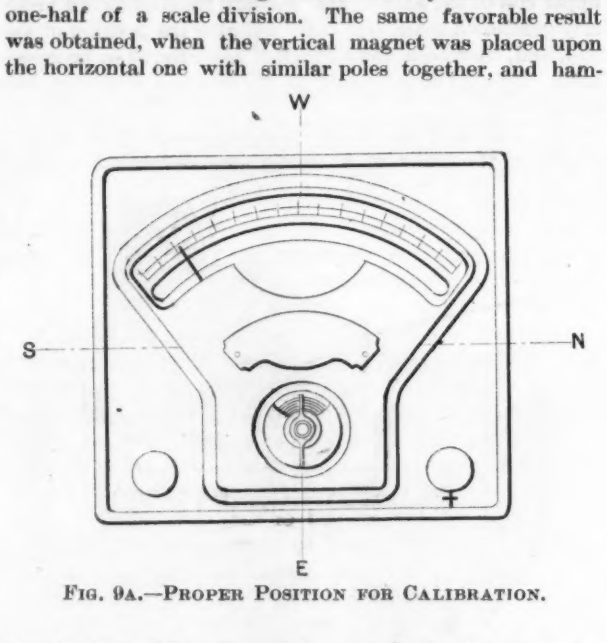


FIG. 9A.—PROPER POSITION FOR CALIBRATION.

As an additional test, the vertical magnet may be left standing upon the horizontal one for months; on removing it the indications of the instrument will be found as correct as in the experiment just explained above.

Although the magnetic field between the pole pieces and iron core is very intense, the instrument is sensitive enough to show to the careful observer very small changes in the reading, if the instrument is turned about its vertical axis, the E. M. F. or current to be measured remaining constant. These slight changes are due to the effect of external magnetic fields, such as that of the earth. In calibrating the instruments proper precautions are taken in having them always in the same position in reference to the earth's magnetic north and south. This position is indicated in the diagram Fig. 9a, and is the same for all the Weston standard instruments. The diagram shows that the binding post marked + in the voltmeters must always point *toward* the *north* and *toward* the *observer*, the observer facing *west*. In the ammeter the two binding posts on the right side of the instrument must be brought into the same position. This precaution is especially necessary if very accurate measurements are to be made. Influences of external magnetic fields may be avoided also by turning the instrument about its vertical axis, noting the maximum and minimum readings and taking the mean of the two readings obtained; this mean will be the correct result.

§ 10. *Influence of Temperature.*—A very important point in electrical measuring instruments, particularly in voltmeters, is their dependence on changes of temperature, whether caused by variations outside of the apparatus or by the heat produced by the current within the apparatus itself. The latter point requires the most careful attention, especially in electric light plants, as the indications of the voltmeter become too low by the heating effect of the current, in consequence of which the engineer will be apt to raise the voltage of the dynamo, to the disadvantage of the lamps.

Careful tests of the Weston voltmeters have shown that a variation of 35 degrees F. above or below 70 degrees F. does not affect their readings more than one-fourth of one per cent. As far as the heating effect of the current within the instrument is concerned, it has been impossible to detect any variation of the readings with any voltages within the readings of the instrument. The changes due to increased resistance of the heated copper wire being counterbalanced by the changes taking place by the same cause in the other parts of the system. The voltmeter may therefore be inserted into the circuit for any length of time without sensibly affecting the accuracy of its indications.

In the Weston ammeters the independence of outside temperature is not maintained with so high a degree of perfection as in the voltmeter, still, they also answer perfectly well in this respect all practical requirements. In these a change in temperature of 35 degrees above or below 70 degrees F. causes an error of one per cent. at the utmost; the readings exceed the true value by this small amount if the temperature rises as high as 105 degrees and fall short of the true value by the same amount, at a temperature of 35 degrees. In regard to the heating effect of the current it may be added that changes keep within one per cent. for all ammeter ranges up to 150 ampères. Improvements being made now will, with all probability, reduce this temperature considerably. In the highest range standard portable ammeters, viz., for 200, 250 and 300 ampères, the heating effect of the current is somewhat higher. If, therefore, very high accuracy is required the instrument should not be kept in circuit for any length of time.

It might at first seem likely that the zero point of the apparatus could not remain constant on account of the expansion of the springs due to changes of temperature. This is avoided by a very simple device: the turns of the one spring run oppositely to those of the other, so that any expansion due to temperature is corrected completely and therefore has no influence on the zero or the readings.

Lightning Arresters, and the Discovery of Non-Arcing Metals.—I.*

BY ALEXANDER J. WURTS.

During thunder storms electric wires become charged from the atmosphere with an electric potential, different from that of the earth; there is then a tendency to establish an equilibrium, that is, for a discharge to or from the earth, as the case may be. If this discharge be left to choose its own path, it will select one or many of the weaker points, usually the most vital part of the system, and there rupture the insulation. It therefore becomes necessary to rid the line of this charge in some suitable manner, and without allowing it to damage any portion of the system. This is usually accomplished by the well-known air-gap lightning arrester. Benjamin Franklin, nearly 150 years ago, drew sparks across an air gap from a charged conductor very much as we do it to-day. He, however, did this to demonstrate the presence of the charge, while we do it for good riddance.

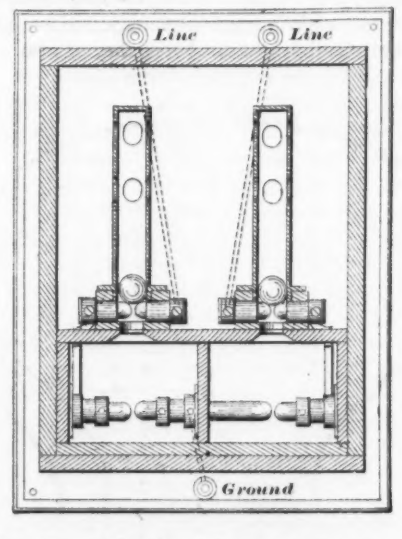


FIG. 1.—THE FIRST WINSOR-WURTS LIGHTNING ARRESTER.

Shortly after the erection of the first telegraph line by Morse in 1844, it was found necessary to provide means for discharging the line during thunder storms, and numerous devices were brought out and patented for this purpose. The main features of lightning arresters from that time till recently have been the "spark gap" and the "kicking coil," the latter being interposed between the discharge circuit and the apparatus to be protected. The spark gap arrester on telegraph lines answers the purpose admirably. When, however, electric lighting was introduced, the lightning arrester problem became more difficult in consequence of

*A paper read before the American Institute of Electrical Engineers, New York, March 15, 1892.

the dynamo short circuit that invariably follows the discharge. It then became necessary to provide means for promptly interrupting this short circuit, and so the fuse was added, and then there followed all kinds of automatic devices for interrupting the short circuit and restoring the arrester to its normal condition. But most of these devices have been more or less defective and unsatisfactory, and now that high potentials are used, the proper interruption of the short circuit becomes more difficult than ever. The ideal lightning arrester would be a simple discharge gap of such a character as not to permit a short circuit of the dynamo, or better yet, metallic connections to the ground without dynamo leakage.

When I first became interested in this subject, I was naturally guided somewhat by previous practice, which had been to provide with each arrester and discharge circuit an automatic circuit interrupter. Fig. 1 illustrates my first practical step in this direction, and represents the Winsor-Wurts lightning arrester, the fundamental idea of which emanated from Mr. Paul Winsor, who proposed that a discharge gap be placed in the neck of a bottle, the idea being that the heat of the arc formed by the short circuit would sufficiently expand the air in the body of the bottle to blow out the arc. With this idea as a nucleus, the arrester depicted in Fig. 1 was evolved. Referring to the figure, it will be noticed, without going into detail, that the arrester is double-pole and that each discharge gap is placed in the centre of an air chamber. In the upper part of each of these there is a slotted passage, which might correspond to the neck of a bottle, and in which there is placed a second air gap in series with each of the others. The second air gap is bridged with a carbon ball, the latter being held in place by tubes having vent holes in the sides and rubber bumpers at the top. The action which takes place when a discharge to ground is made with a resulting short circuit is as follows: the arc at either or both of the jumping spaces instantly heats and expands the air in the respective air chamber, which, rushing up through the slotted passages, blows either or both carbon balls to the top of the tubes. The arc formed

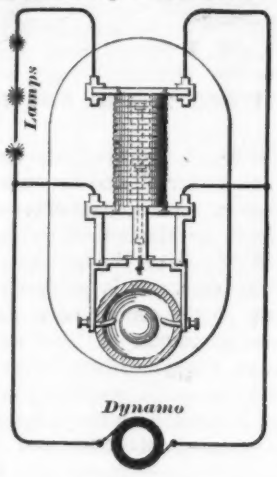


FIG. 2.—THE WINSOR-WURTS ARC CIRCUIT LIGHTNING ARRESTER.

where the circuit has been broken by the projected carbon ball is, at the same time, instantly blown out, thus completely rupturing the circuit. The only demonstration is a quick puff as the air rushes out of the holes near the upper ends of the tubes. The object of the holes is obvious. As the balls are confined in the tubes they at once drop back to their former positions, and thus automatically place the apparatus in a condition ready for another discharge and short circuit. In testing this arrester the terminals are connected to the circuit of a 1,000-volt generator. The air spaces are bridged over with a fine wire to take the place of an actual discharge. Then by the throw of a switch the full pressure of the machine is placed on the arrester. There is an enormous rush of current, the temporary wire bridges fuse, arcs are formed, the air expands with an explosion, the balls fly up, more arcs are formed, tongues of fire shoot out of the holes in the tubes, the upper arcs are blown out, the balls drop back to their normal positions, and all this happens like a pistol shot, without causing more than an insignificant flicker in the lamps. It is very curious to notice that if this short circuit is made on the crest of a wave of an alternating current, the report of the explosion is much sharper and louder than when the circuit is closed at the instant the wave is at or near the neutral point. I might add here that, after short circuiting a 1,000-volt 3,000-light machine through such an arrester about 400 times, there was not the slightest deterioration to be noticed anywhere. Those who are not familiar with this kind of work will hardly appreciate this last fact, or realize what is accomplished each time the arrester "goes off."

Soon after this arrester was completed, steps were taken to adapt the same principle to an arc circuit lightning arrester, which resulted in the one illustrated in Fig. 2. By referring to the figure, you will notice that a vertical solenoid provided with an iron core is connected in the main circuit beyond the point of contact with the discharge circuit. The discharge electrodes are curved arms which swing freely through the sides of a cylindrical air chamber, and the construction is such that when the core falls the discharge electrodes will be forced out. The action is then as follows: Under normal running conditions the core is held up in the solenoid, but if a discharge occurs from both sides at once short circuiting the machine through the discharge points, the solenoid will at once lose its power, the core will fall and force the discharge arms out through the holes in the walls of the chamber. This action would draw out arcs three inches long, and the heat thus generated is sufficient to cause a sudden expansion of air in the air chamber and thus blow out the arcs even though the current be but ten ampères and the pressure 3,000 volts. Without the device just described for lengthening the arc, the heat developed would have been insufficient. In short-circuiting a 50-light machine through this arrester, there is

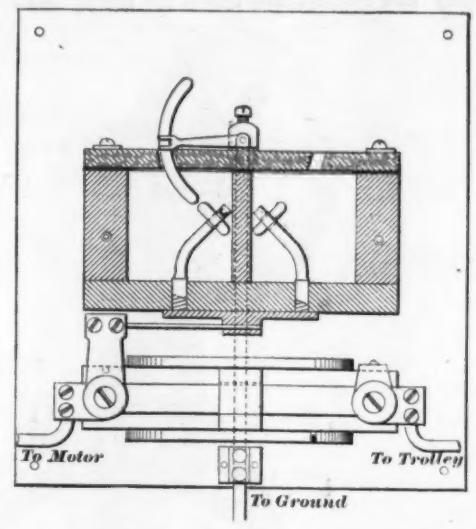


FIG. 3.—THE WINSOR-WURTS LIGHTNING ARRESTER.

a scarcely perceptible flicker in the lamps, the core drops, the short circuit is opened and the core drawn back into its normal position ready for further action, all in an instant of time. Although I have used an electromagnetic device in the construction of this type of arrester, it will be noticed that the placing of a coil in the lightning arrester circuit has been avoided, so that even though every discharge has to pass through this coil to reach the discharge points, yet from this point on the discharge has a non-inductive path to earth through the arrester in preference to the dynamo.

Neither of these arresters would interrupt a short circuit on a 500-volt direct current generator, so, after some further experimenting, the arrester shown in Fig. 3 was evolved. Referring to Fig. 3, it will be noticed that there are two air chambers, in each of which is a fixed carbon discharge point. Above these chambers is a curved carbon swinging freely from one chamber to the other through suitable openings, so that either end of the curved carbon, as the case may be, shall come into close proximity to either of the fixed discharge points. The action is as follows: When a discharge takes place it passes to one of the fixed discharge points, depending upon the position of the curved carbon, then across the air space to the curved carbon, and from there to the ground, as shown in the figure. The dynamo current then following causes an arc to be established between the curved carbon and one of the fixed points, and the heat generated by this arc expands the air in its respective chamber, increasing the pressure therein, and causing the curved carbon to be instantly blown from one chamber to the other. This ruptures the arc and adjusts the arrester for the next discharge. In testing this arrester 500-volt and 1,000-volt generators have been repeatedly short circuited through it, and in every case the circuit has been instantly broken without injury to the dynamo, and the arrester has as quickly reset itself in readiness for future use. In one of the tests made to demonstrate its promptness and reliability, the fixed points were so adjusted as to touch the curved carbon in either of its

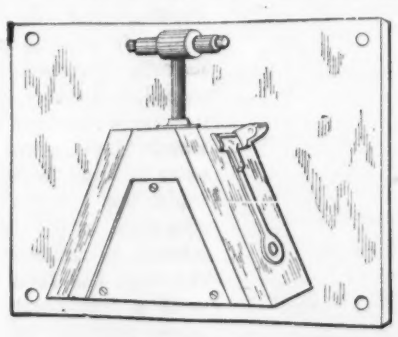


FIG. 4.—THE POWER CIRCUIT LIGHTNING ARRESTER.

two normal positions. A 1,000-volt generator was then short circuited through the arrester, which resulted in the circuit being repeatedly opened and closed without injury to either dynamo or arrester. This power circuit arrester was afterward much improved, and finally took the form shown in Fig. 4, and the arrester shown in Fig. 1 was also finally changed to this form. This arrester is made of iron and marble, and its advantages over the others are its non-combustibility and the double break in connection with the air blast. Fig. 5 illustrates the same arrester, fitted into an iron box lined with asbestos, and in this shape is adapted to either car or pole use.

So far you will observe that my one object had been to provide a simple, reliable and non-inductive circuit interrupter. In this I had succeeded as far as immediate wants were concerned, but with the prospects of higher voltages in the near future the problem seemed but imperfectly solved. The experiments of Lodge, Hughes and others were carefully studied, and I finally decided that it might be well to repeat some of them. So, one day, while casting about for some suitable means of experimenting, I happened to be passing under a driving belt; my hair stood on end, and my body became charged. Of course somebody had to touch my ear (that seems to be the proper thing to do under the circumstances), and my body became discharged. That evening while thinking over the events of the day, my thoughts rested on this belt, the electrified atmosphere around it, and the charging and discharging of my body, and I wondered whether the phenomena observed were not very similar to those experienced during thunder storms. On the following day I stretched about four feet of No. 14 insulated wire under a belt, parallel to it, and about two inches below it. I then brought the ends to a convenient place where I could ground the wire or not as I chose. The room was then darkened, the belt set in motion, and a most beautiful sight presented itself. Between the belt and the wire were seen soft purple streamers, giving the appearance of a film connecting the belt and wire. In some places these streamers were more dense than others, and in this were suggestive of the Northern lights. There was no disruptive discharge at all between the belt and wire. On bringing the bare end of the wire within one quarter of an inch of a ground a continuous discharge took place. When one end was well grounded no spark could be drawn from the other end. When one end was grounded through a choke coil consisting of about 40 turns of No. 14 wire, small sparks could be drawn from the other end, showing the impedance offered by the coils to the discharge. When neither end was grounded both ends showed "side flash" every two or three seconds. So far, these results seemed to correspond with the experience met with in electric systems when exposed to the influence of thunder storms. The conditions also seemed to be very similar. Here was a wire stretched through an electrically disturbed atmosphere; the wire became charged, and the charge passed readily to ground through a metallic discharge circuit containing an air gap. An induction coil impeded the discharge, and when there was no ground connection there

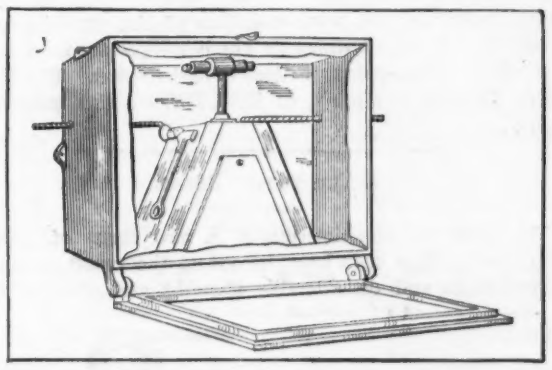


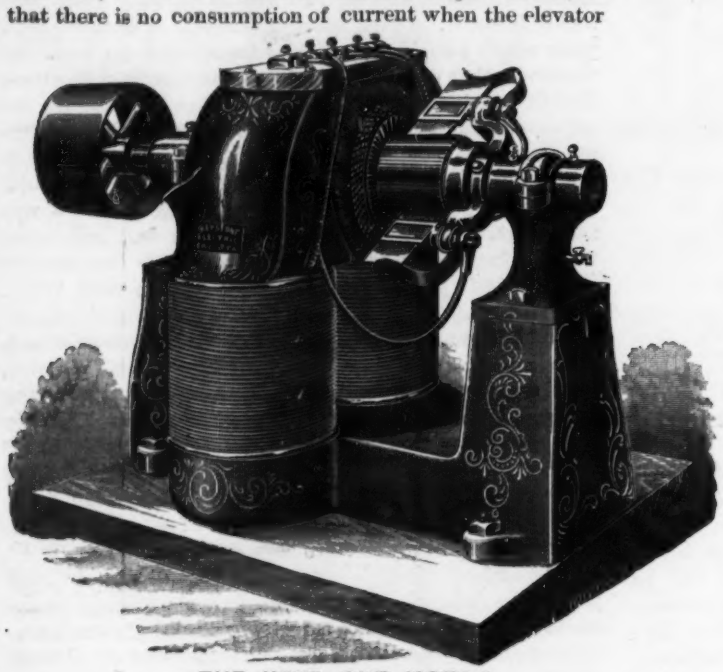
FIG. 5.—THE POWER CIRCUIT LIGHTNING ARRESTER.

was side flash. All these results seemed to correspond with practice.

The thought then occurred to me, "What would happen if I were to string a second wire near and parallel to the first, and ground it, leaving the first wire insulated?" A second wire was quickly strung, but before making the ground connection the following observations were made. The purple streamers seemed equally divided between the first and second wires, and either would give about equal sparks. On grounding the second wire no indication of a charge on the other could be obtained. The streamers were now all directed to the second wire, and the first was as inert as a block of stone would have been. If, now, in these laboratory experiments there were reproduced the conditions existing between electric wires and the atmosphere during thunder storms, then, to prevent wires from becoming charged, all that would be necessary would be to stretch a grounded wire near and parallel with the wire to be protected, and, in fact, it would seem as though one such grounded wire would protect all the wires that could be strung on any one line of poles. An explanation of these phenomena is not far to seek. An insulated wire lying on the surface of the earth cannot become charged from the atmosphere, because the latter is at the same potential as the earth; but an insulated pole line can be, and is charged when exposed to the influence of thunder storms, because the atmosphere surrounding the wire is at a different potential from the earth; therefore with an insulated pole line, and an adjacent grounded parallel wire, the grounded wire in effect transfers the earth to the level of such wires, but if a grounded wire near and parallel to an insulated wire in effect causes the earth to be transferred to the level of the insulated wire, then the insulated wire cannot become charged. The grounded wire running over the poles will relieve the atmosphere in its neighborhood of any difference of electric potential that would otherwise exist between that neighboring atmosphere and the earth, and the insulated line would then fail to become charged. Soon after performing this experiment, I learned that such an overhead grounded wire had been used to great advantage, and that being the case was greatly surprised that it was not in more general use.

The Keystone Motor.

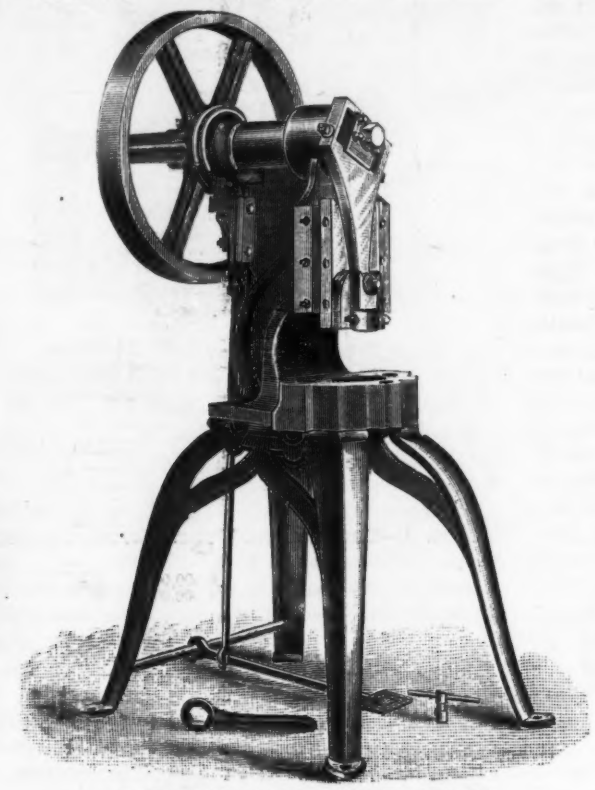
The illustration shows a reversible elevator motor, which can be connected with elevators or hoists of ordinary construction, either by belt, by gearing, or by coupling the armature directly to the end of the driving shaft of the elevator or hoist. These motors are made in five standard sizes, varying from three to 15 horse power, and are operated without rheostat or other outside resistance. They are so constructed that the services of a skilled operator are not required, as the motor can be started, stopped at any point, and reversed easily under full load, and without any perceptible jar. The design is such that the armatures or field coils cannot be injured by careless handling or otherwise; besides, there is a feature of economy connected with its use, inasmuch as the motor runs only when the elevator runs and stops with it, so that there is no consumption of current when the elevator is not in use and the wear and tear of the machinery is lessened. A large number of these motors are in general use, giving, it is stated, the best of satisfaction. The Keystone Electric Company, of Erie, Pa., are the manufacturers.



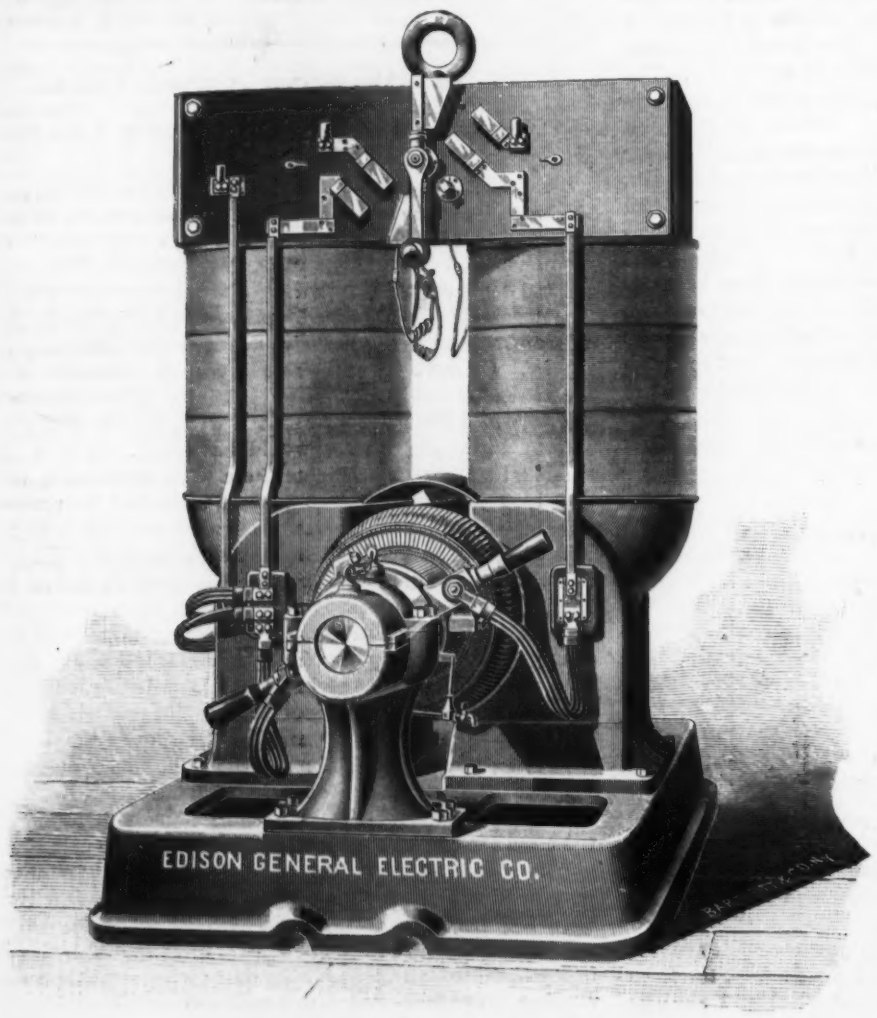
THE KEYSTONE MOTOR.

A New Power Press.

We show in the illustration a new form of power press, which has been brought out as the result of many experiments and considerable thought and study of the types and requirements for presses of this kind. It is known as Wheeler's improved power press, and in its design combines, it is stated, many features which entitle it to be placed in the front rank of presses of the type. One of the features noted in its construction is the incline of adjustment, which, it is claimed, does away with stripping, which is a great annoyance, when heavy strains result from the class of work to which the press may be subjected, as presses should be adapted to all the requirements of light work or heavy strains. Another feature is the use of a double clutch, which has two points of contact, as by its use it is claimed that the cramping, wringing and twisting tendencies common in clutches having only one point of contact are entirely obviated. The working parts of the Wheeler press are all covered with a shield, which protects them from dirt and grit. It is also provided with an automatic brake, by the use of which the press is stopped gradually and evenly, and leaves no perceptible effect in the running of the machine. This brake is automatic in its action, requiring no attention from the operator. Those who have examined it state that its operations are perfect mechanically, the workmanship and material being first class. It is manufactured by Frank Wheeler, of Meriden, Conn.



THE WHEELER POWER PRESS.



THE EDISON BIPOLAR GENERATOR.

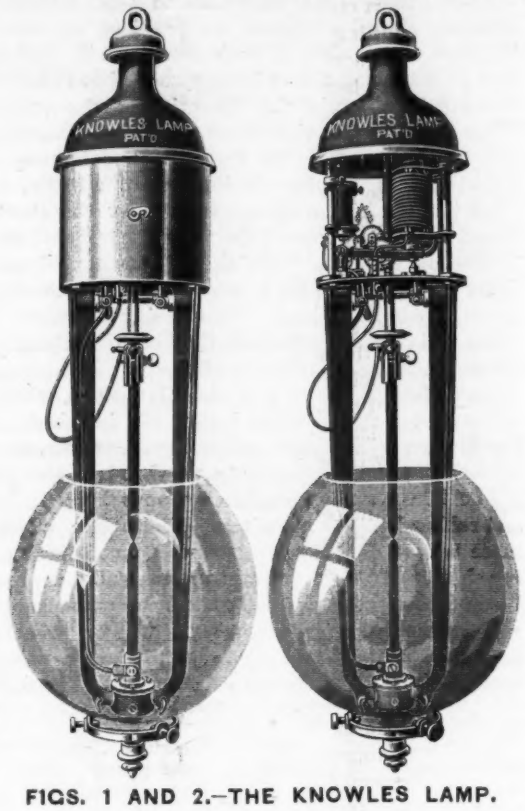
The Edison Bipolar Generator.

The constant aim of manufacturers of electrical apparatus for electric lighting and electric power plants is to introduce new features, eliminating objectionable ones and making improvements which will render that apparatus more efficient. The accompanying illustration shows an Edison 200 kilowatt generator of the latest pattern, which is of the bipolar type, and which incorporates the general features with which electricians are familiar.

The series field is built up of sections, wound on spools which are slipped over the cores and then properly connected up. Should a fault manifest itself it can be located, and the spool in which it appears can be removed, repaired and replaced, or another substituted at once without loss of time. Expenditure for repairs is thus reduced to a minimum. To adapt this generator to the demand of electrical railway service, the field has been provided with a compound winding, easily adjusted to meet the necessary requirements by means of a shunt coil, conveniently placed in the back board of the keeper. The bearings being located close to the base frame, the centre of gravity of the armature is low and great stability is secured. Self-oiling bearings and carbon brushes contribute to diminish the attention necessary to the operation of the generator to a minimum. A considerable number of these high capacity generators have already been installed by the Edison General Electric Company throughout the country, and it is stated the advantages claimed for them are fully appreciated.

The Knowles Arc Lamp for Incandescent Circuits.

An arc lamp for use on incandescent circuits should embody the following essential features: it should be neat in appearance, compact and of light weight, dust and weather proof, well ventilated, simple and accurate in construction, perfect in regulation, noiseless in running, and perfectly insulated. It is the design of the Knowles lamp, shown in the accompanying illustrations, to fill all these requirements as nearly as possible. Its general construction may be seen in the illustrations, Fig. 1 showing the lamp complete and ready for use, and Fig. 2 showing the lamp with the case removed so that the working mechanism may be seen. Its length is 40 inches over all and its weight is 20 pounds. It is neat in appearance and compact in construction. There is no projecting horn on the top of the lamp and no projecting globe-holding tube on the bottom and no unsightly projecting binding posts. It is so designed that it may be hung close up to the ceiling of a room. The dust and weatherproof character of the lamp enables it to be used out of doors without the necessity of its being covered by a protecting hood or canopy. There are only two pieces of insulation in the lamp, and these are of a material which is non-combustible and not affected by moisture. The lamp is non-differential in its character, its feed being positive in its action. The lamp operates normally at about 50 volts pressure and at a current of from 6½ to 7 ampères. It will run two in series on a 110-volt circuit, or as many in series as may be desired, the circuit pressure being the necessary multiple of 50 volts. The lamp will run on any desired current from 5 to 10 ampères, and when once adjusted needs no alteration of adjustment.



FIGS. 1 AND 2.—THE KNOWLES LAMP.

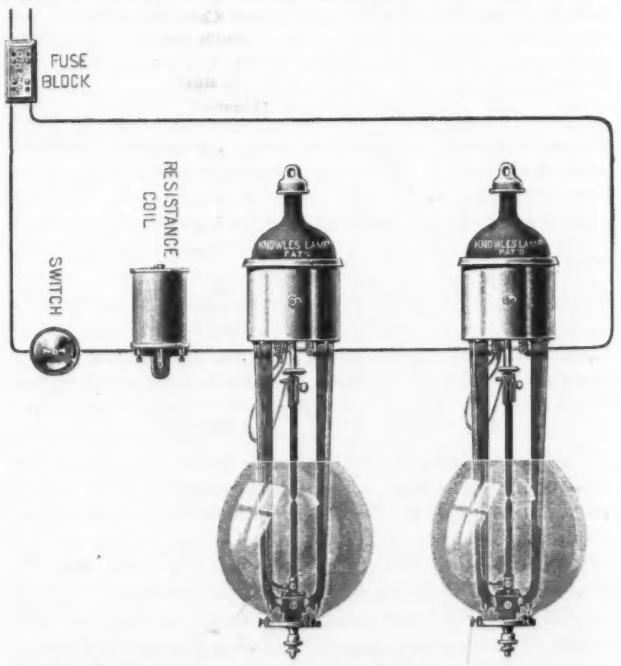


FIG. 3.—THE CONNECTIONS OF THE KNOWLES LAMP.

The lamp, when trimmed with a proper size and kind of carbon, will burn at a current of from 6½ to 7 ampères and at 50 volts pressure for about 12 hours, thus making it a practical all night single carbon lamp, and doing away with the necessity for a double carbon lamp.

Fig. 3 shows the manner of connecting and arranging the lamps when two are run in series upon a 110 volt circuit. The diagram is the same for other combinations of lamps.

The lamp was invented and patented by Edward R. Knowles, chief electrician of the Schuyler Electric Company, of Middletown, Conn., and has been adopted by the Thomson-Houston Electric Company, for all of its offices.

Improving the Financial Basis of the New York Electric Club.

The Board of Managers of the Electric Club have issued a circular letter to all members of the club to the effect that for the present the excellent café which has been maintained at the headquarters of the club would be discontinued. This step was found to be necessary since the income of the club was insufficient to meet its current liabilities. For some time the expenses have exceeded its receipts, and this, it is said, was principally due to the expense of running the café and to a lack of its substantial support by the members. The running expenses of the club under the new conditions, it is thought, will be within the income. To provide for the indebtedness previously incurred, a resolution has been passed by the Board of Managers assessing active members of the Club $30 each, and associate members, $15 each. The treasurer desires that a check be sent by each member not later than March 31 for the proper amount, and it is hoped that every member, both active and associate, will recognize the importance of prompt attention to this request, since the continuance of the club, and the retention of its club house depend upon the prompt collection of this assessment.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, March 19, 1892.

The stock market during the week has presented very few features of interest, and on the whole has been dull and unattractive. As for some time past, the bulk of the business has been on the specialties and confined almost entirely to railway and sugar stocks. The market is largely a professional one, and the public has but little interest in it, but the general tendencies are decidedly bullish, and all attempts at activity result in a rise in prices. So long as speculation continues to be so closely circumscribed strength can develop only very slowly, but there are evidences of it on every hand. The money market is in a thoroughly lifeless condition, so far as activity in loans is concerned. There is little or no business paper offering. The West is more abundantly supplied with funds than ever before, and therefore western paper fails to make the usual activity among Eastern banking circles. Rates, however, remain about the same here: three to four per cent. for call loans; four to five and one-half per cent. for time loans, with the supply exceeding the demand.

In the Boston stock market the West End Street Railway stock has been one of the most attractive cards of the week, and has scored a large advance. The earnings of this company, under the electric system, far exceed the most sanguine hopes of its projectors. These figures are a powerful argument in favor of electric motive power in large cities. About one-half the earnings of the entire system comes from the electric lines, although much less than this proportion of the mileage is equipped with electricity. The earnings for February increased, gross, $29,492, and it is thought the net will be as much if not more.

Westinghouse stock has displayed continual strength during the week, and sold at higher figures. The buying is always ahead of the supply, and the brokers confidently expect still higher figures on this account. Preferred stock has sold as high as 49, an advance of seven points over the preceding sale of a few days previous.

Thomson-Houston has been very quiet with but very few sales, but the quotations show an advance ever those of last week.

Edison Stock.—There have been very few sales of Edison stock, and the price remains at 96½-97. No one looks for good prices even in electric stocks on such a dull market as the present one.

The stock of the Toronto Incandescent Electric Light Company (Ld.) is selling on the T oronto (Can.) Stock Exchange at 20 per cent. premium. This company commenced operations two years since, and now has a paid up capital stock of $500,000. Six per cent. dividends have been paid since the start.

The right to deposit Thomson-Houston and Edison electric stocks under the consolidation agreement will expire Monday, 21st. More than 75 per cent. of all the Thomson-Houston stocks has been deposited, and it is expected that nearly all will have come in within a few days.

Northwest Thomson-Houston Company.—The books of the Northwest Thomson-Houston company close to-day, for the annual meeting at St. Paul, April 4.

Thomson-Houston Trust Securities "Series D " and Fort Wayne "Series A" will pay dividends very soon.

Western Union has been bought by many, especially by traders identified with the movement in the stock a month ago. It is stated that the buying was influenced on the belief that the Postal bill now before Congress was in the interest of the Western Union and would result in increased receipts and decreased expenses.

Thomson-Houston International, it is thought, may be absorbed by the Thomson-Houston-Edison consolidation. The basis talked of is $225 for the $600,000 common stock and par or a new preferred share for the $400,000 preferred. The latter pays 7 per cent.

Dividends.—The Worcester (Mass.) Electric Light Company has declared a semi-annual dividend of four per cent.; holders of Westinghouse electric securities are receiving a dividend on the scrip which was issued to them on Sept. 1, 1890. It covers 13 months interest. This scrip was issued in lieu of a dividend and is convertible into common stock; The Commercial Cable Company pays a dividend of one and three-quarters per cent. April 1. The Thomson-Houston Carbon Company paid a semi-annual dividend of four per cent. on the preferred stock March 15. The American Loan and Trust Company as trustee of Fort Wayne series A will pay a dividend of 16 cents per share April 1 to stock of record on March 24. The Municipal Electric Light Company, of Brooklyn, N. Y., has declared a quarterly dividend of 2½ per cent., payable April 2.

Bonds for Sale.—Five hundred and fifty thousand dollars Denver Consolidated Electric Company six per cent. gold first mortgage sinking fund bonds dated Oct. 15, 1890, are being offered by E. H. Rollins & Sons, of Denver. They are due in 25 years, but under the terms of the sinking fund the company has to redeem $10,000 each year, beginning with the sixth year at 103. The company has a paid up stock of $750,000, bonded debt (six per cent.) $750,000; value of plant over $2,000,000. The company was organized in 1881 and has always earned 10 per cent. net, and has paid regular 10 per cent. dividends for several years. It does the exclusive lighting of the whole city of Denver, and has in operation the following lights: Arc and municipal system, 2,520; incandescent, 46,736; motor service, 185 h. p.

Increase in Capital Stock.—The capital stock of the Springfield (Ore.) Electric Light and Power Company has been increased to $50,000.

To Issue Stock.—The Laconia (N. H.) Electric Light Company at a recent meeting voted to issue the $10,000 of stock now in the treasury as preferred stock at six per cent.

Closing Quotations.—The following were the closing quotations of electric stocks on Saturday, March 19, 1892, in New York, Boston and Chicago:

NEW YORK QUOTATIONS.

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
Western Union Telegraph Co	100	86,200,000	87⅞	88
Commercial Cable Co	100	7,716,000	150	152½
Edison General Electric	100	15,000,000	96½	97
Edison Illuminating Co., of New York	100	4,500,000	81½	82½
" " " Brooklyn	100	750,000	76	80
" " " Chicago	100	750,000	138	142
U. S. Illuminating Co	100	1,250,000	30	35
Edison Elec. Light Co. (of Europe) stock	100	2,000,000	2½	5
" " " " bonds	sh	30,000	65	75½
" Ore Milling Co	100	2,000,000	15	20
" Toy Phonograph Mfg. Co	10	1,000,000	....	½
Brush Illuminating Co., of New York	50	1,000,000	40	50
Mt. Morris Electric Light Co		500,000	20	40
East River Electric Light Co	100	1,000,000	....	60
North American Phonograph Co	...	6,600,000	4½	6
New York Phonograph Co	...	2,000,000	3	4
Automatic Exhibition Co	...	2,000,000	2	2½
New England Phonograph Co	...	2,000,000	1¾	2¾

BOSTON QUOTATIONS.

	Par.	Capitalization.	Highest.	Lowest.	Bid.	Ask'd.
Thomson-Houston Elec	25	6,000,000	59	58¼	59	59¼
Thomson Houston Elec. preferred	25	4,000,000	29	28⅞	28¾	28⅞
Thomson-Houston Elec.—Series C	sh	40,000	9	....	8½	9
Thomson-Houston Elec.—Series D	sh	120,000	8	7¾	7⅞	8⅛
Thomson-Houston Int'n'al Elec	100	600,000	....	....	200	225
Thomson-Houston Int'n'al Elec—Pfd	100	400,000	....	....	103	105
Thomson Elec. Weld	100	1,000,000	54	....	55	60
Thomson European Elec. Weld	100	1,500,000	....	....	12	12½
Westinghouse Elec.—New Com.	..	6,000,000	27¾	27¼	27¼	27¾
Westinghouse Elec.—Pfd.	..	4,000,000	49	...	49	....
" Trust receipts"	..	10,000,000	16⅞	16	16½	16¾
Fort Wayne Elec	25	4,000,000	12⅞	12½	12¾	12⅞
Fort Wayne Elec.—Ser. A.	sh	80,000	7½	....	7½	7⅞
Detroit Elec	10	1,000,000	....	....	8	....
West E n St. Ry. Co.—Com	50	7,150,000	77⅛	76½	76	76¼
West End St.Ry.Co.—Pfd	50	6,400,000	87½	87	86¾	87
American Bell Tel	100	15,000,000	205¼	204	203	204
Erie Tel. & Tel. Co	..	4,800,000	46¼	....	46	46½
Mexican Tel. Co	10	1,280,000	1.10	....	1.00	1.10
New Eng. Tel. & Tel. Co.	..	10,304,600	51½	....	51	....
Tropical Tel. Co	10	400,000	35c.	....	35c.	....

CHICAGO QUOTATIONS.

Chicago	$230@ $232	Cumberland	$60@ $62
Central Union	56	Wisconsin	118@ 120
Michigan	81@ 83	Bell of Missouri	175@ 180
Great Southern	30@ 32	Iowa Union	20@ 22
Colorado	34@ 36	Missouri & Kansas	51@ 53
Rocky Mountain Bell	40@ 43		
Chicago Arc Light and Power	$85½@ $91	Chicago Edison Co	$145@$148

NEW INCORPORATIONS.

Messrs. Robinson and Moore, of Everett, Wash., with a capital stock of $5,000, have formed a partnership to construct and operate an electric light plant.

The Central Construction Company, of Baltimore, Md., with a capital stock of $200,000, has been formed to construct and equip electric and other railways. J. W. Hall, J. Gill and D. Stewart are the incorporators.

The Ridgway Electric Light Company, of Ridgway, Pa., capital stock $10,000, has been formed to supply light, heat and power to the public. C. M. Jackle, Fred H. Ely and E. C. Ross, all of Ridgway, are the incorporators.

The Wolverine Electric Light Company, of Holland, Mich., capital stock $25,000, has been formed for the production of electricity for light. E. W. Richmond, James Huntley, John E. McLane, all of Holland, are the promoters.

The Escanaba Electric Street Railway Company, of Escanaba, Mich., capital stock $50,000, has been formed to construct an electric street railway. James Lillie, of Kankakee, Ill.; Jno. K. Stack and James B. Moran, of Escanaba, are the promoters.

The Edgerton Electric Light Company, of Edgerton, Wis., with a capital stock of $6,400, has been formed to erect, maintain and operate an electric light plant to furnish power, etc. F. W. Coon, M. Peltin and W. T. Pomeroy are the incorporators.

The Seattle & Everett Railroad Company, of Seattle, Wash., capital stock $500,000, has been formed to build and operate railroads, electric light and telephone and telegraph lines. R. Hilton, J. P. Fay and Herman Chapin, all of Seattle, are the promoters.

The Electric Launch and Navigation Company, of Camden, N. J., capital stock $300,000, has been started to manufacture and deal in electricity for light, heat and power. J. Parker and R. Gihon, both of Philadelphia, and J. H. Holloway, of Camden, are the organizers.

The Pneumatic Fire Alarm Telegraph Company, of Philadelphia, Pa., capital stock $250,000, has been started to carry on the business of manufacturing mechanical or electrical appliances. The organizers are J. M. Harlan, Franklin H. Herst and H. N. Day, all of Philadelphia, Pa.

The Electric Construction and Supply Company, of Jersey City, N. J., capital stock $225,000, has been formed to manufacture, sell, lease, mortgage or otherwise acquire and dispose of electrical materials, etc. F. A. Kinsman, Arlington, N. J.; B. B. Ward and T. T. Grover, New York City, N. Y., are the incorporators.

The Bayonne City Electric Light and Power Company, of Bayonne, N. J., capital stock $50,000, has been incorporated to supply that city with electric light and power. W. H. Peddle, Roseville, N. J.; R. Stewart, E. A. Dugan, Jersey City, N. J., and J. T. Olhausen, of Elizabeth, N. J., are the organizers.

The Leavenworth Electric Railway Company, of Leavenworth, Kan., capital stock $300,000, has been formed to maintain and operate a street railway in Leavenworth and from Leavenworth City to Fort Leavenworth. The organizers are G. A. Baker, J. C. Lysle, Geo. Burrows and William Dill, all of Leavenworth.

The Standard Battery Company, of Chicago, Ill., capital stock $1,000,000, has been formed to manufacture, operate and sell galvanic and other batteries, and all other electrical machinery, appliances, etc., and to deal in patents relating thereto. Fred. M. Bailey, Chas. A. Haslett and Sterling L. Bailey are the incorporators.

AFFAIRS OF THE COMPANIES.

The Thomson-Houston Electric Company will hold its annual meeting April 12.

The Northwest Thomson-Houston Electric Company will hold its annual meeting April 4, at St. Paul, Minn.

Iron Mountain, Mich.—Mr. Francis A. Brown has been elected president of the Iron Mountain Electric Light Company, vice Robert Bankes, resigned.

The Coatesville Electric Light, Heat and Power Company, of Coatesville, Pa., has given notice that on March 28 application will be made for its charter.

The People's Electric Light, Heat and Power Company, of Braddock, Pa., has elected the following officers: W. J. Vance, president; A. T. Reid, vice-president; A. D. Wilson, secretary.

The Consolidated Electric Light Company, of Burlington, Vt., at a recent meeting elected the following officers: President, U. A. Woodbury; vice-president, W. S. Vincent; secretary and treasurer, F. H. Parker.

To Apply for a Receiver.—It is stated that the Continental Trust Company, of New York, will apply to the United States District Court for a receiver for the Lansing, Mich., City Electric Street Railway Company, on the claim that the road and its affairs are in such a condition that the company must be reorganized.

The McKeesport Electric Light Company, of McKeesport, Pa., which has been in the hands of a receiver for some time, will probably be sold, as the court has been asked to grant a rule ordering the sale of the plant to pay the claims against it. The principal claims are held by the Edison people and the People's bank, of that city.

The F. B. Morgan Light and Power Company, of Cincinnati, O., has made an assignment. The assignee is Frank L. Thompson. The liabilities, it is stated, are about $10,000, and assets $6,500. Preferences in the way of chattel mortgages were given to J. J. Smith for $345.70, to Thomas A. Logan for $150, and the Commercial Bank for $1,000.

The Pasadena Electric Light and Power Company, of Pasadena, Cal., at its annual meeting elected the following officers: President and manager, L. C. Torrance; vice-president, R. Doty; secretary, J. S. Torrance; treasurer, San Gabriel Valley Bank. The board of directors is composed of L. C. Torrance, M. E. Wood, L. J. Crowell and J. S. Torrance.

The Elmira, N. Y., Electric Light Works and the Electric Street Railway system of 23 miles have been purchased by the Elmira Municipal Improvement Company, a syndicate in which it is stated D. C. Robinson, Mayor of Elmira; Gen. Woodward, President of the Third National Bank, N. Y.; Jackson Richardson, President Elmira National Bank; Hon. Smith M. Weed, of Plattsburg, N. Y., and D. Graham, President of the Montreal and Chicago Shipping Company, are interested.

The Cooperstown (N. Y.) Illuminating Company is to go out of business. The Attorney General has begun an action in the Supreme Court against the company, and Judge D. Cady Herrick has appointed William H. Bierne to be temporary receiver of the company's goods and effects. The complaint sets forth that the corporation is insolvent and has been for a year past, and is unable to discharge its debts and obligations. Judgments have been obtained against it, and a large amount of indebtedness exists, which is far above its assets and liabilities.

The Bell Telephone Company will hold its annual meeting March 29, when the recommendation of the directors of the company of an issue of $2,500,000 of new stock will be submitted to the stockholders. The right to subscribe to the new stock will, it is also understood, apply to stock of record at the close of business on March 29. The proceeds of the new issue will be used, it is stated, to pay for extensions of the long-distance service and other improvements. The annual report of the directors, will, it is stated, make the best showing ever put out by the company.

The Thomson-Houston Light, Heat and Power Company, of Binghamton, N. Y., has become involved in trouble. J. E. Shapley, of Binghamton, has secured an injunction restraining Messrs. Gould, Miller, Keys, and Pruyn, of Oneonta, N. Y, from interfering or disposing of any of the stock of this company. This company for four years has furnished lights for the streets. For several weeks past the Binghamton Gas and Electrical Company has been endeavoring to gain a controlling interest in the Thomson-Houston stock, and as a result the plant is to be sold upon judgments amounting to $3,345.69. The plant is valued at $75,000.

The Brush Electric Company held its annual meeting in Cleveland, March 15. The following directors for the ensuing year were elected: S. A. Barton, Boston; J. S. Bartlett, Boston; Myron T. Herrick, Cleveland; J. Potter, Cleveland; C. A. Coffin, Boston; William B. Bolton, Cleveland; S. M. Hamill, Cleveland. Immediately after the stockholders' meeting the new board of directors met and elected the following officers: S. A. Barton, president, Boston; John S. Bartlett, first vice-president, Boston; C. A. Coffin, second vice-president, Boston; S. M. Hamill, secretary; L. B. Le Vake, assistant secretary; J. Potter, treasurer; A. H. Hough, assistant treasurer; William B. Bolton, general counsel; J. F. Hughes, auditor; S. H. Short, general electrician; F. A. Scheffler, superintendent; C. W. Phipps, assistant superintendent; S. M. Hamill, general manager, all of Cleveland. Advisory committee: J. Potter, William B. Bolton, S. M. Hamill. Manufacturing committee: S. H. Short, F. A. Scheffler, S. M. Hamill.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, March 21, 1892.

Mr. C. E. Scott, treasurer of the Bristol (Pa.) Electric Light and Power Company, favored us with a call last week. His company has just declared the usual five per cent. dividend, and completed a new addition to its plant, 50 × 80, out of the earnings during the year.

A. E. Plowman, formerly with Wm. H. Weston & Co., Philadelphia, is now representing Messrs. Porter Bros. & Co., 78 Worth street, N. Y., who are introducing a new and valuable composition which they claim will do the work successfully in most of the situations where hard rubber is now being used.

The New York Electrical Society will hold a meeting in Prof. Chandler's room at Columbia College on Friday, March 25, at 8 P. M. Prof. F. B. Crocker will lecture on electrical measuring instruments, and his remarks will be illustrated by means of the large collection of instruments belonging to the college.

American Institute of Electrical Engineers.—The annual meeting for the election of officers, the reception of yearly reports and the transaction of business will be held at the headquarters of the Institute in this city on Tuesday, May 17, followed by a dinner

in the evening. The general meeting for the reading and discussion of professional papers will be held at Chicago on Monday and Tuesday, June 6 and 7. The programme of papers is in preparation, and full particulars will be given out later.

A bill for continuing the Board of Electrical Control has been introduced in the Legislature by Assemblyman Hogan. Favorable expressions are heard in favor of the bill in so far as it provides for another year's official life for the board, as it is thought that another year ought to bring the work which it has begun near to completion. It is claimed, however, that many of the provisions of the new bill are open to criticism, as the Board of Electrical Control is a body created for the express purpose of placing electric wires underground. A large amount of work has been done in that direction; but under the new bill and its provisions the Subway Commission will not only have authority to extend the time for burial of overhead wires, but they will be authorized to grant the privilege of erecting new poles and stringing new wires. It is believed also that privileges for the use of trolley wires can be granted by the commissioners under this bill.

A bill to incorporate the General Electric Company has been introduced into the Legislature. It is made up of special privileges and powers, including a reduction of the franchise tax, and is in the nature of a test measure. It has been introduced on account of the pending consolidation of the interests of the Edison and the Thomson Houston Electric companies, and, if it is favorably considered, it is stated that the consolidation of the two comaanies will be followed by an incorporation under the liberal laws of the State of New Jersey unless New York State offered the stockholders something like equal privileges and powers to those they could secure in New Jersey. Legal representatives of the Edison company state that such a bill if passed would enable the stockholders of the Edison and Thomson-Houston companies, who are considering consolidation of their interests, to incorporate the consolidated company under the laws of New York instead of going to New Jersey as, of course, corporations will go to the State which is most liberal toward them in the granting of powers and the matter of taxes.

New Members of the American Institute.—The following have been elected associate members of the American Institute of Electrical Engineers: Fred DeLand, Western manager of THE ELECTRICAL WORLD, 465 The Rookery, Chicago, Ill.; Elisha Gray, Highland Park, Ill.; Adolf Graner, electrical patent agent, 529 North Thirty-fifth street, Philadelphia, Pa.; John N. James, electrician, Naval Observatory, Washington, D. C.; A. F. McKissick, professor of electrical engineering the A. & M. College of Ala., Auburn, Ala.; Lee L. Summers, assistant electrician, Western Union Telegraph Company, 18 Western Union Telegraph Building, Chicago, Ill. The following transfers from associate to full membership have been made: Charles B. Burleigh, electrician, Thomson-Houston Electric Company, 620 Atlantic avenue, Boston, Mass.; Robert Edward Dunston, president the Connecticut Motor Company, Plantsville, Conn.; Angus S. Hibbard, general superintendent American Telephone and Telegraph Company, 18 Cortlandt street, New York City; Charles H. Wilson, general superintendent Chicago Telephone Company, 203 Washington street, Chicago, Ill.; Park Benjamin, electrical expert and engineer, 32 Park Place, New York City.

A Bill for a Telephone Commission.—The Gardner telephone bill, creating a Commission to determine the rates which shall be charged for service by telephone companies, has been introduced in the legislature by Assemblyman Malone. It is stated that while the Telephone Subscribers' Association favors this bill, it is not opposed to bills introduced by Rice and Cahill, but that it took up the Commission bill for the reason that it found that the legislatures before which committees appeared to urge the first bill thought the measure too radical. If the present Legislature thinks either the Rice bill or the Cahill bill preferable to the Malone bill, the passage of either will give satisfaction to all the users of telephones. A meeting of the executive committee of the Telephone Subscribers' Association was held on Saturday last in the rooms of the Board of Trade and Transportation. Arrangements were made to send a large delegation to Albany on Wednesday of this week, when the Assembly Committee on Electricity will give a hearing on the bill to establish a telephone commission for this city and Brooklyn. The Senate committee, it is stated, will give the delegation a chance to express their views. The association's delegates will be accompanied by a committee of 25 from the Board of Trade and Transportation. L. H. H.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
927 CHESTNUT STREET, PHILADELPHIA, March 19, 1892.

The Moore & White Company reports business for friction clutches as being very good.

Horn, Brannen & Forsyth.—This firm is introducing a new line of goods in the line of electric fixtures.

High & Dampman, who have recently opened an office at 47 North 7th street, Philadelphia, deal in engine specialties, belts, etc. They will devote their energies more particularly to the electric branch.

An Immense Iron Bridge Combination.—Negotiations which have been pending between the Tennessee Coal and Iron Railroad Company, with the de Bardeleben Coal and Iron Company, and the Sloss Iron and Steel Company, have been successfully consummated. The capitalization of these consolidated interests will be $19,000,000 of stock.

The Philadelphia Traction Company has succeeded in getting the Councils to pass its ordinance in favor of the trolley system. It was favorably reported to Select and Common Councils, by the following vote, 14 in favor and 4 against. So Philadelphia may soon see her hopes realized as far as is at present possible in the line of electric rapid transit.

The Star Electrix Company.—Mr. D. C. Spruance states that his company is manufacturing a new double pole switch. Also a new single pole switch. The company has recently installed in its factory an alternating plant, and besides increasing the size of its factory is putting in new machinery of different kinds, such as milling machines, drawing presses and nickel plating plants.

Chas. A. Schieren & Co., through their agent, Mr. G. H. Fisher, of the Philadelphia office, report they have taken a contract from the Trenton Passenger Railway Company, of Trenton, N. J., for four electric belts, each 24 inches in width and 112 feet in length. Also sold the Powelton Electric Company, of Philadelphia, a 36-inch double electric belt, 132 feet in length. These are two of the more prominent contracts of many they have taken recently.

The electric light installation at the Hotel Brighton, Atlantic City, under the supervision of Dr. A. Drysdale, the consulting engineer, has been completed, and the hotel opened to the public. The installation was done on short notice and was completed in 30 days. The United States Electric Lighting Company did the wiring for the hotel and furnished two dynamos which are run by two high speed automatic cut-off engines, furnished by the Stearns Manufacturing Company, of Erie, Pa. When it is taken into consideration that the specifications, drawing, etc., had to be prepared and the building wired for 650 lights, many of the room lights being one or two light fixtures, the time given for the installation was remarkably short.

Opposed to the Trolley.—A meeting of the Union Committee, opposing the Traction company's trolley ordinance, was held in the Board of Trade rooms, at noon, Tuesday, March 15. It was reported that the city is being placarded with maps, showing the extensive routes of the trolley lines, and the number of narrow streets in the centre of the city that the Traction company proposes to occupy. Canvassers are going over the proposed routes, getting the signatures of the property owners to petitions against the erection of the trolley in the city. This is only one of the organized protests that the Philadelphia Traction Company are meeting with, for their proposed trolley system for this city. The papers of this city seem to be divided in regard to the adoption of the trolley system, and at present the Councils are investigating the advantages and disadvantages of such a system for this city. The evidence so far presented by such men as Mr. O. T. Crosby, of the Thomson-Houston Company; Mr. Short, of the Short Electric Company; Mr. Westinghouse, and other electrical experts, would prove conclusively, that as regards the system being attended by any dangers to the public at large, from the experience in other cities, that there is no system that could offer more advantages from every point of view than the trolley, and certainly their opinion is more worthy of consideration than the statements of those who are in no position to express opinions relative to the different systems that are now being operated through the agency of electricity. W. R. W.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
Boston, Mass., March 19, 1892.

Mr. George E. Bowers, of Fitchburg, Mass., was in town last week on business connected with his new winding lathe.

Frank S. DeRonde, representing the Standard Paint Company, was in town recently looking after the wants of their numerous customers.

Pettingel!-Andrews Company.—By a recent decision of the Patent Commissioner, the validity of the K. W. cut-out patent has been conceded and established beyond all question.

E. C. Wilcox & Company, electrical contractors and supply dealers, will hereafter make their headquarters at 222 Pearl street, Hartford, but will continue their store at Meriden as a branch.

Mr. W. S. Bishop, of 958 Grand street, New Haven, Conn., is building a new 5 h. p. motor that has a tension base, is well built mechanically, and gives great efficiency. He is meeting with great success in the sale of the same.

The Framingham Brass Manufacturing Company has been incorporated at South Framingham to furnish stamping and screw machine work to electric manufacturers and others. Henry L. Sawyer, president; Jas. J. Valentine, treasurer; H. E. Swift, vice-president and manager.

Mr. R. S. Brown, New England Agent Westinghouse Electric Company, has just closed contracts with the Fairfield and Waterville (Me.) Electric Railway Company for six gearless equipments, also ten car equipments with single reduction type of motors for the Boston Construction Company.

The Eddy Electric Company, of Windsor, Conn., have bought additional property adjoining their factory and will immediately build an addition of two stories and a basement completely duplicating their present plant. Mr. M. E. Baird, the general agent of this company, has just returned from a very successful Western and Southern trip.

The new electric railway from East Hartford to Glastonbury is finished and cars will be started this week. The road is five miles long and will at first give all the different motors a trial. One Thomson-Houston, one Edison and one Westinghouse are now in use. S. H. Barrett, who has been connected with the industry for several years, will be the superintendent.

Mr. L. E. Jerome, of the Connecticut Clock Company, New Haven, has just returned from a very successful trip, and the following well known houses will hereafter handle their alarm clock: Western Electric Company, Chicago; St. Louis Electrical Supply Company, St. Louis; Engineering and Electrical Supply Company, St. Paul; Franklin Electrical Supply Company, Kansas City; Consolidated Electric Supply Company, Omaha; Partrick & Carter, Philadelphia; Electric Gas Lighting Company, Boston; The E. S. Greeley & Co., New York.

Messrs. A. G. and F. G. Waterhouse, well known in the electrical industry by their former connection with the Waterhouse and Westinghouse electric companies, are now located at 302 Asylum street, Hartford, Conn., under the firm name of Waterhouse Bros., where they have been for the past year working up a system of arc lighting, a novel line of motors, which will apply on arc as well as incandescent circuits, and a set of details consisting of an electric meter, lightning arrester and a number of special devices which will be valuable contributions to the electrical trade.

The Hubinger & Pool Electric Company, of New Haven, Conn., have their new factory rapidly under way. It will be 100 × 25 with an addition 40 feet square for engine, boiler and blacksmith shop. The company will build slow speed motors and dynamos from one h. p. to 150 h. p. They have just ordered from the Prentice Tool and Supply Company, New York, some $10,000 worth of machinery consisting of engine lathes, planers, horizontal boring machines, shapers, milling machines, radial drills, upright drills, two Fremont power presses, etc. Their capital stock to commence with is $50,000, all paid in. The Hubinger Brothers are well known capitalists, and will supply all necessary money to make the company a complete success. C. A. B.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, March 19, 1892.

Mr. J. M. Thomas, the secretary of the Chicago Belting Company, is convalescing in New Orleans.

Force Bain is placing a new form of hot wire lightning arrester on the market. He is also manufacturing 50 voltmeters for a local supply house.

Mr. C. A. Daigh, of the Electrical Engineering and Supply Company of St. Paul, and the National Electric Manufacturing Company of Eau Claire, Wis., was in Chicago this week.

Electrician Sargent has been ordered by the Columbian Exposition directors to go to Europe to ask foreign manufacturers to make bids on the Exposition power and electric lighting plant.

Mr. L. M. Cox, the well known Washington expert and all around live agent, made a flying trip to the Northwest this week, stopping over a day in Chicago to inspect the World's Fair Buildings.

Mr. Fred. W. Horne, of the Railway Department of the Thomson-Houston Electric Company, had a column letter in Sunday's *Chicago Herald* "In defense of the trolley" that is interesting and timely.

Mr. William Bracken, president of the Consolidated Electric Company, of New York, was in Chicago at the opening of the bids for the electric launches at the World's Fair, and left for home on Saturday evening's limited.

The Chicago Arc Light and Power Company is reported to be considering the advisability of erecting a handsome station on the northwest corner of Franklin and Washington streets across the street from the Telephone building.

The Howard lamp is the latest bulb to be brought to the attention of the incandescent fraternity, and is backed by a year's excellent record. It will be placed on the market by the Great Western Electric Supply Company, Chicago.

Mr. William E. Roberts, general manager of the Rockford Electric Manufacturing Company, Rockford, Ill., has been passing a few days in Chicago, and winning friends on every side, and it is gratifying to learn that success is already attending his systematic business-like methods.

The Stearns Manufacturing Company, of Erie, Pa., on and after May 1 will establish a branch office in Chicago, which will be under the management of Mr. A. S. Griswold, who has been with the firm a great many years. Their office will be located at room 1,120 "The Rookery."

K. McLennan, No. 3,841 Forest avenue, Chicago, has enlarged the capacity of his works and is now turning out a greater quantity of Gale's commutator compound and his special insulating compound than ever before. The latter, it is stated, has been found economical and efficient, and is giving universal satisfaction.

Mr. James Boland has been appointed superintendent of construction of the Chicago Arc Light and Power Company. This promotion is well merited, Mr. Boland having been foreman of construction for several years and being thoroughly acquainted with the location of the numerous underground circuits.

The Sperry Electric Mining Machine Company, Chicago, has issued a circular calling attention to its standard fuse wire, and indicating the best lengths for use and the fusing points for such lengths. If longer lengths are used the fusing points will not vary, but when shorter lengths are used the carrying capacity will be increased.

A Sad Bereavement.—Mr. and Mrs. George A. McKinlock are mourning the death of their little daughter Marion. Mr. and Mrs. McKinlock were married on Dec. 2, 1890, and passed some 12 months abroad. It was while in Paris, a year later, that little Marion came to crown their happiness. Then they all returned to Chicago, and the baby enjoyed perfect health till a week ago, when attacked with an illness that proved fatal on Thursday morning. It needs no words to tell how deeply the father's heart is touched, and so unconsciously our voices are softened, our hands grasp his the more firmly, and our eyes speak the sympathy we fain would give expression to.

To Ask for New Bids.—The World's Fair Exposition officials are dissatisfied with the bids offered by electric companies on furnishing 5,000 arc lamps for the illumination of the buildings and grounds at Jackson Park, and the Committee on Grounds and Buildings at its recent meeting rejected the bids sent in for furnishing the light indicated and decided to advertise anew for propositions for supplying the necessary arc lights. Only two bids were received, from the Thomson-Houston company and the Western Electric Company. The Thomson-Houston company's bid was for 6,000 arc lamps at $38.50 each, making a total of $231,000. The Western Electric Company submitted a bid for 500 lamps only and at the rate of $31.25 per lamp, making a total for this number of $15,625.

The Terry Dinner.—Seldom has a more congenial party of friends gathered to welcome a new comer to Chicago than met in the Union League Club on Tuesday evening, March 15, when the right hand of fellowship was extended to Mr. A. S. Terry, who has secured an interest in the Sunbeam Incandescent Lamp Company. He will hereafter reside in Chicago, moving his family there from Ansonia, Conn., where for more than 20 years he has been connected with the Ansonia Brass and Copper Company, having entered the company's service as an office boy and rising to the position of head of the manufacturing department of one of their extensive factories. The entire affair was an entirely informal one given by Mr. Franklin S. Terry to enable a few personal friends to meet his brother, and the dinner that the sixteen guests sat down to was laid with the perfect service for which the club is so justly noted. After the coffee was served and the cigars lighted warm words of welcome were expressed by Mr. Charles H. Beasley, indicating the pleasure the guests felt in forming the acquaintance of one who had left so honorable a record behind him, both as an active worker in hist company and as a director in the local bank and in local corporations; and with these remarks were mingled pleasant comments on the good work that Mr. Terry would find Chicago striving to accomplish, work that will add so largely to the material prosperity of the entire Union. Mr. Francis W. Parker said that Mr. A. S. Terry would find that Chicago is not only noted for the rapid accumulation of honest wealth, but also for the generosity of its citizens in advancing the interests of art and science and literature, and that before the present decade ended it would become the Mecca of the wise men. Mr. W. A. Kreidler, in tendering the freedom of the Electric Club to Mr. A. S. Terry, made brief mention of what it had accomplished in arousing an interest in the electrical industry and furthering the cause of electrical education. Mr. George H. Meeker spoke gratefully of the greeting he had received when establishing his headquarters in the city, of the harmonious relations existing among the electrical fraternity and of the high standard of personal achievement that follows as a result of the stimulating activity prevailing in Chicago; that the majority of the successful business men in Chicago were comparatively young men possessing a reserve force of energy enabling them to develop possibilities hardly dreamed of by their intimate friends; men who find a real enjoyment in not only accomplishing the end sought and performing the task assigned, but also in doing whatever else fell in their pathway. Mr. A. S. Terry responded to the welcome given him. Mr. Meeker suggested a toast to the brothers Terry, which was drank standing. A justly merited compliment was then paid to the host of the evening, Mr. F. S. Terry, who has demonstrated his ability to cope with every problem presenting itself; has anticipated growth and prepared for it, and has had the satisfaction of seeing the Electrical Supply Company of Chicago grow under his guiding hand from mere desk room on Lake street to the great warehouse it now occupies on the lake front; and thus having renewed the bonds of good fellowship the company separated. Those present included Mr. A. S. Terry, Messrs. C. H. Besley, F. W. Parker, G. H. Meeker, F. B. Badt, M. A. Knapp, E. W. Bennett, J. H. Cooke, W. A. Kreidler, Dr. S. C. Stanton, W. T. Humes, J. R. Fletcher, Wm. Taylor, D. E. Goe, George G. Carter, Fred De Land, and Franklin S. Terry. F. DeL.

News of the Week.

THE ELECTRIC LIGHT.

Athena, Ore., is to have electric lights.

Warren, L. I., is now lighted with electric arc lights.

Pullman, Wash., is to have a new electric light plant.

Homer, Mich.—The town has voted in favor of electric lights.

Haselton, O.—The new electric lights have been put in operation.

La Grange, Ga., will vote on April 4 on the question of electric lighting.

St. Charles, Ill., has contracted for a city electric light plant to cost $8,500.

Anderson, Ind.—T. D. Bosworth is contemplating an extension of his electric light plant.

Metropolis, Ill.—The City Council has let the contract for a new electric light plant.

Dresden, O., will vote on the question of bonding the town for $5,000 to pay for electric lighting.

Richmond, Va., is contemplating an issue of $125,000 in four per cent. bonds to pay for an electric light plant.

Bismarck, Dak.—The electric light plant has been sold, and the apparatus is to be shipped to Brenham, Tex.

Portage, Wis.—The Portage Electric Light Company contemplates putting in a 750 light incandescent dynamo.

Fond du Lac, Wis.—A franchise has been granted to F. B. Hoskins and W. G. Curtis for an electric lighting plant.

Owosso, Mich.—The Owosso Electric Light Company has been granted a three-years' franchise for lighting the town.

Farmville, Va., by a vote of 175 to 17, has voted to purchase the local electric lighting plant and increase the same.

Akron, O.—The plant of the Akron Electric Light Company will be increased to 6,000 incandescent and 750 arc lights.

Waukesha, Wis.—The Waukesha Electric Light Company contemplates adding an engine and dynamo to its plant.

Westfield, N. Y.—The town has voted in favor of putting in an electric light plant to be operated under municipal control.

Dundee, Ill.—Authorities are investigating various electric light systems, with a view to putting in a plant for this town.

Lake Providence, La.—The Lake Providence Electric Light Company has completed its plant and is in successful operation.

La Grange, Troup County, Ga., will vote on April 4 on the question of water-works and a municipal electric lighting plant.

Oil City, Pa.—The local authorities are contemplating the purchase of the electric lighting plant and the improvement of the same.

The Bridgeport (Conn.) Electric Light Company will erect a new plant April 1, and contemplates adding new condensing engines.

Dover, N. H.—The Consolidated Light and Power Company will put in an electric light and power plant at York Beach this summer.

Brenham, Texas.—The Brenham Compress, Oil Mill and Manufacturing Company will put in a $50,000 ice and electric lighting plant.

Saginaw, Mich.—The Saginaw Electric Light and Power Company has been making improvements in its plant by the addition of new dynamos, etc.

Holland, Mich.—The electric plant of Huntley & Holly has been organized into a stock company by J. W. Beardsley, Alfred Huntley and others.

Troy, N. Y.—The Troy Gas Light Company has issued bonds to the amount of $500,000, the proceeds to be used for the purchase of an electric light plant.

The Fort Plain Gas, Light, Heat and Power Company, of Fort Plain, N. Y., has just installed a 650-c. p. Thomson-Houston alternating machine.

The Pioneer Electrical Company, of Aberdeen, S. Dak., has purchased the electric lighting plant and franchise at Lead City, and will proceed to operate the same.

Rochester, Minn.—The City Council has contracted with the Western Electric Company, of Chicago, for a city electric light plant. The amount of the bid was $15,541.

West Chester, Pa.—Citizens are agitating for the proposed electric lighting plant, and the question will likely be decided at the next meeting of the Borough Council.

East Concord, N. H.—The Concord Land & Water Power Company, through Geo. A. Blanchard, is making a canvass of the town with a view to introducing the electric light.

The Pioneer Electric Light Company, of Aberdeen, S. Dak., has been granted a franchise by the City Council for operating an electric light system in the city, for a period of 20 years.

Holley, N. Y.—The Board of Village Trustees have been authorized to contract for the electric lighting of the streets for the period of three years at the expiration of the present contract.

St. Peter, Minn.—The bid of the Thomson-Houston company of $13,700 for an electric light plant of a capacity of 50 arc lights and 1,000 incandescent lights has been accepted by the City Council.

Augusta, Ga.—The contract for city lighting has been let to the Augusta Electric Light and Power Company for $72 per arc light of 2,000 c. p. The contract is for five years, beginning in July, and is for 250 lights.

THE ELECTRIC RAILWAY.

Mount Holly, N. J.—It is stated that an electric road from here to Burlington will at once be built.

Minneapolis, Minn.—R. R. Robbins, President of the North Side Company, States that his company has decided to extend its line to Robbinsdale.

Atlanta, Ga.—The Atlanta, Hopeville & Manchester Railway Company will construct an electric road to connect these two places. It will be nine miles long.

Fredericksburg, Va.—The Rappahannock Electric Light and Power Company has been purchased by the Fredericksburg Street Railway Company and it will enlarge the plant.

St. Louis, Mo.—A project is on foot, supposed to be promoted by C. C. Rainwater and E. C. Donk, to build an electric road from Gang avenue to Arsenal street across the Grand avenue bridge to the city limits.

New Orleans, La.—On May 20, in the Council Chamber of the City Hall, at 12 noon, will be sold at public auction to the highest bidder the right of way for street railway purposes over certain streets. Otto Thoman is comptroller.

The new electric street railway from East Hartford to Glastonbury, Conn., four miles, will begin running cars about April 1. The trolley system will be used. The cars have been purchased, and the wires, etc., are nearly completed.

Jacksonville, Fla.—Council has passed an ordinance permitting the Jacksonville Street Railway to use electricity as a motive power and President H. S. Haines states that the company will probably take steps in that direction ere long.

West Haven, Conn.—The New Haven & West Haven Horse Railroad Company is getting ready to equip its lines with electricity, providing permission can be gained from the city authorities, and it is expected to have the lines equipped by July 1.

Middletown, Conn.—It is stated that the Schuyler Electric Company will purchase the franchise and property of the Middletown Horse Railroad Company with a view to substituting electricity for horse power. It also intends to extend the line.

To Have the Trolley.—The new syndicate which now controls the Globe Street Railway lines of Fall River, Mass., at a meeting of its Executive Committee recently, closed contracts for reconstructing the road and equipping it with the trolley system.

The amount of capital required to build the electric street railway from Lowell, Mass., to the Boston and Maine depot in Haverhill, the petitioners for a charter state is $1,398,000. The Amesbury and Haverhill Electric company asks for a capitalization of $250,000 stock and $300,000 bonds. The two together make a total of about $2,000,000.

The Dubuque (Ia.) street railway lines, which are to be equipped electrically, as stated in THE ELECTRICAL WORLD of March 19, will be equipped with Detroit Electrical Work's Standard motors, the contract having been let to the Detroit Electrical Works instead of the Edison General Electrical Company as was stated in the issue of THE ELECTRICAL WORLD referred to above.

LEGAL NOTE.

The Accumulator Company Enjoined.—In the United States District Court, at Trenton, N. J., recently, Judge Green granted a preliminary injunction against the Accumulator Company, of Newark, restraining it from infringing on certain patents held by the Brush Electric Company. The defendants opposed the granting of the injunction on the grounds that new evidence has been found since the decision against them rendered by Judge Coxe in the Southern Circuit of New York. This new evidence is to the effect that Dr. Blanchard, of Vermont, discovered the storage battery 20 years before the invention of Brush's storage battery.

PERSONALS.

Mr. Erastus Wiman, it is stated, is to resign from the presidency of the Great North Western Telegraph Company, a letter to that effect having already been sent to the directors.

Mr. J. H. Gibson, formerly with the Short Electric Railway Company, has taken charge of the entire electric system of the Wyoming Valley Traction Company, of Wilkesbarre, Pa.

MISCELLANEOUS NOTES.

The New Jersey Corporation Tax Bill.—The new tax law passed by the legislature has been signed by Governor Abbett. By its provisions telegraph, cable and telephone companies are taxed 2 per cent. upon their gross receipts, and electric light companies ½ of 1 per cent. on their gross receipts.

For Electrical Experiments.—Senator Peffer has introduced a bill in Congress to establish an electrical experimental station for the purpose of investigating and determining whether electricity can be profitably used and applied as a motive power in the propulsion of farm machinery. It was referred to the Committee on Agriculture.

Electricity in Mining.—An electric lighting and power plant has been installed at the Cargo Muchaco mines on the Colorado River, a short distance above Yuma, Colo. The mill, offices, boarding houses and other buildings are lighted with 16 and 32 c. p. lamps. The same dynamo that furnishes the light also furnishes power for electrical hoisting machines, and is placed in a drift 550 feet below the surface.

The Western Union Telegraph Company, it is stated, has no franchise for Denver, Colo. Members of the City Council claim to have discovered that the company never obtained a franchise to run wires in the city, and the matter is to be investigated fully. Examination of the records fails to show that a franchise was ever granted. The company appears to have come in at an early day and to have developed as naturally as though it were part of the city.

The following bills have been introduced in the Ohio Legislature: To prevent the tapping or unauthorized use of electric lighting on power wires. Providing that it shall not be lawful to generate or use for distribution to the public any continuous or pulsating electric current with sufficient pressure to produce death accidentally by the direct action of such current. Taxing telegraph, telephone, and other companies, and creating a board of tax examiners.

Electrical executions were discussed at the regular meeting of the New York Section on Public Health and Legal Medicine, of the Academy of Medicine, Wednesday evening, March 16. Dr. Carlos F. MacDonald read a paper on "The Infliction of the Death Penalty by Electricity." A general discussion followed, which was taken part in by Drs. Rockwell, Morton, Smith, Landy, Mr. Jenks, of the Edison company, and others. It seemed to be the general opinion that execution by electricity was a success, but that improvements would undoubtedly be made in the method of application.

The San Miguel Consolidated Gold Mining and Milling Company, of Telluride, Colorado, have just ordered an addition to their equipment, of one 250 h. p. Westinghouse alternating current synchronous motor, and one 750 h. p generator. They will do some electric lighting from the dynamo, and in addition to the heating of their offices, which they are now heating from their old plant, they will, with the new one, heat their entire mills. They have had a 100 h. p. motor running from 150 h. p. generator for over a year, with perfect satisfaction; and no load that they have been able to throw on has yet been able to throw the motor out of synchronism with the generator.

A Much Patented Invention.—The United States Patent Office granted a patent to Thomas A. Edison last week on the manufacture of filaments for incandescent lamps, for which application was filed on March 20, 1880. The same process has been patented in no less than 13 countries, as will be seen by the following list which accompanies the specification. It was patented in England Sept. 16, 1880; Italy, Nov. 6, 1880; Canada, Nov. 11, 1880; Belgium, Nov. 15, 1880; Victoria, Dec. 13, 1880; Austria-Hungary, Jan. 7, 1881; Queensland, Feb. 7, 1881; New Zealand, March 7, 1881; Portugal, March 31, 1881; New South Wales, April 2, 1881; Spain, April 26, 1881, and in France, June 19, 1881.

Industrial and Trade Notes.

The E. J. Ford Electric Company, of Fort Worth, Tex., are Texas agents for the Taylor battery, meters and new slow speed motors.

Mr. C. R. Prouty, Eagle Pass, Tex., is in the market for incandescent lamps showing different colors in the same bulb for use in an electric fountain he is building.

The Chapman Valve Manufacturing Company, of Boston, manufacturers of valves and gates, have sent out a special circular and price list in regard to the special makes of valves which the company manufactures.

The Metropolitan Electric Supply Company, (Limited), of London, Eng., have removed to new offices adjoining its Manchester Square station. The new address of the company is 17 South street, Manchester Square, W.

The Clark System of Arc Lighting.—The Clark Electric Company, of 192 Broadway, New York, is sending out a neat illustrated descriptive catalogue of this system, and of the electrical specialties which the company manufactures.

Albert & J. M. Anderson, of 21 Hamilton street, Boston, manufacturers of Ætna insulators and Anderson line material, have sent out a neat illustrated and descriptive catalogue and price list of the specialties which they manufacture.

The Electrical Engineering and Supply Company, of St. Paul, Minn., reports business as very satisfactory. Mr. F. J. Cram, general agent of the company, reports having taken a large number of orders in Montana, among which a contract made with the Deer Lodge Electric Company, of Deer Lodge, Mont., was the largest. The company states that, judging from its sales of weather-proof wire this month, companies in the Northwest evidently are making many extensions of their mains, and that indications point to a very large business this year.

The Electric Appliance Company, of Chicago, is exhibiting a very fine line of New England double pole snap switches ranging from 10 to 100 ampères, and with regular covers and flush caps. The flush cap switch is a recent improvement in snap switches, and is intended for special work where it is desirable to have the switch set in the wall, making the top of the switch flush with the surface. These are coming into use largely, and the Electric Appliance Company has arranged to meet the demand by carrying them in both the New England double pole and the Acme 10 ampère single pole switch.

Masters & Veneman is the title of a new firm which has just started in the electrical construction and supply business in Evansville, Ind. They will carry a complete line of supplies, and will add to and increase their stock as demand justifies, and will also contract for construction work of all kinds and install isolated and central station plants. Mr. E. L. Masters has been in the electrical business for about ten years, and for the past three years has held the position of superintendent of construction with the Evansville Gas and Electric Light Company. Mr. A. J. Veneman has also been in the employ of the Evansville Gas and Electric Light Company for about four years. During the last year he was connected with the Electrical Supply Company, Chicago, Ill., as salesman, which has enabled him to attain a thorough knowledge of electrical supplies of every description. The new firm succeeds A. J. Veneman, who is a member of the firm.

Business Notices.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

The Mather Electric Motors combine the highest efficiency and workmanship consistent with a reasonable first cost. Perfect automatic regulation of speed from no load to full load. For catalogue and information address E. T. Pardee, agent, 14 Butler Block, Syracuse, N. Y.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

U. S. PATENTS ISSUED MARCH 15, 1892.

470,654. Electric Railway; Edward M. Bentley, of Boston, Mass. Application filed Dec. 11, 1885. The combination, with two electric railways having separate sources of current, of a section of conductor common to both of said railways, but insulated from the main conductors of one road.

470,656. Motor for Electric Cars; Francis O. Blackwell, of Boston, Mass., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed Dec. 4, 1890. The combination with the driven axle of a car-truck, of a four-pole electric motor having its armature geared to the axle and its field magnets recessed at the dividing polar line receiving the axle.

470,657. Contact Devices for Electric Railways; Francis O. Blackwell, of Boston, Mass., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed Jan. 26, 1891. The combination, in an electric railway, of one or more supply conductors enclosed in a slotted conduit, with a contact device comprising a shank going through the slot, and a folding contact maker or makers traveling on the conductors, and thereby furnishing means for supporting the contact device, and means for connecting the contact device with an electrically driven vehicle.

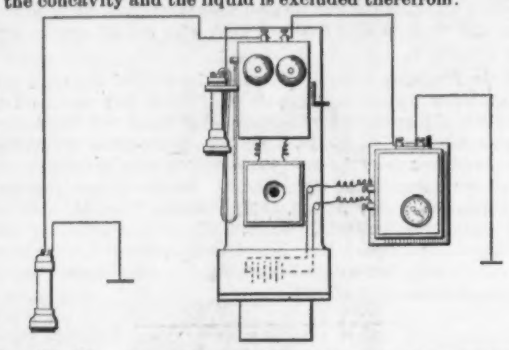
470,666. Police and Fire-Alarm Signaling Apparatus; Leroy B. Firman, of Chicago, Ill. Application filed April 1, 1889. In a police electric signaling system, the combination, with a metallic circuit, including a battery and transmitting and receiving instruments, of an earth-branch circuit, said transmitting instrument being provided with mechanism for connecting and immediately disconnecting said branch with said metallic circuit by the operation of said transmitting instrument prior to its sending the number signal, a relay in the metallic circuit operating whenever said metallic circuit is interrupted to connect said metallic circuit with a second earth branch at the central office, said second earth branch including an electromagnetic device which, when energized electrically, operates to open said earth branch circuit at the central office.

470,667. Combined Police and Fire-Alarm Signal Apparatus; Leroy B. Firman, of Chicago, Ill., Assignor to the

Police Telephone and Signal Company, of same place. Application filed Nov. 28, 1890. The combination of a main circuit containing a battery or source of electric energy, a signal sending device and a relay, a second circuit operated by said relay, a shunt to the main circuit containing a signal-sending device, an additional battery, and a magnet or compensating relay with a signal-receiving device on the main circuit being responsive only to the current strength of both batteries.

470,697. Protector for Electrical Apparatus; Charles H. Morse, of Cambridge, Mass. Application filed Jan. 12, 1892. An electromagnetic protector having two independent helices in opposite sides of the circuit including the apparatus to be protected, an armature extending across the cores of said helices, two contacts respectively connected to the opposite sides of said circuit and one contact connected to the earth, and a shunting or short circuiting and grounding weight normally locked to the said armature, but adapted to be released therefrom when the said armature is attracted to said helices and to fall vertically and make connection with the contacts.

470,701. Secondary Battery; George F. Parker and Charles E. Crapo, of Rochester, N. Y., Assignors of one-half to Edwin S. Hayward, Jr., of same place. Application filed April 10, 1891. A dome shaped metallic plate for secondary batteries, provided with tapering recesses for the active material extending through the plate and arranged in the exciting fluid in the horizontal position with its concavity downward, whereby the gases are retained in the concavity and the liquid is excluded therefrom.



No. 470,786.—Appointment Signal for Telephones.

470,721. Lightning Arrester; Elihu Thomson, of Lynn, Mass., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed Dec. 26, 1889. The combination, with an arc-rupturing magnet, of the arcing electrodes connected to a circuit supplied from a source of energy sufficient to maintain a continued arc once formed from one to the other, and presented to one another on a line parallel to the lines of magnetism or line joining the poles of said magnet. (See illustrations.)

470,722. Telltale Device for Electric Circuits; Edgar Tregoning, of Malden, Mass., Assignor of one-half to Alvin E. Bliss, of same place. Application filed Oct. 2, 1891. The invention consists of a solenoid placed in a lamp circuit and having a movable tubular core provided with contact pieces, a break in the main circuit causes the core to fall, completing a local circuit containing an alarm. (See illustration.)

470,736. Lightning-Arrester; George M. Bacon, of Scranton, Pa. Application filed Aug. 10, 1891. A lightning arrester, consisting of discharge points, the former in circuit with the line, the latter with the solenoid, the core connected with the solenoid, the discharge point connected with the core, and the point connected to ground.

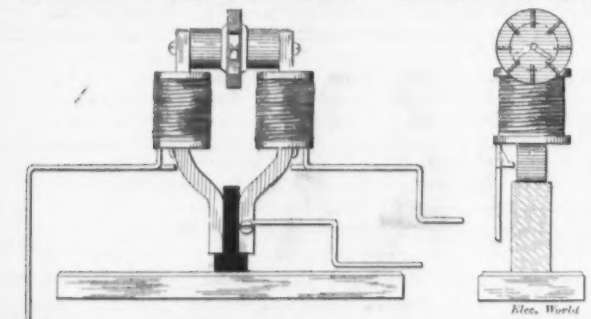
470,748. Electric Switch; Samuel Deacon, of Lynn, Mass., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed March 18, 1889. The combination, with an electric switch, of an actuating mechanism, a connecting spring between the switch and actuating mechanism, and a catch or holding device engaging with the switch for holding the same from movement while the spring is being subjected to strain by the actuator.

470,749. Field Magnet for Dynamos; George Edensor Dorman, of Chicago, Ill., Assignor to the Standard Electric Company, of Illinois. Application filed Dec. 17, 1890. In a dynamo electric machine a series of short overlapping arc shaped segments with inwardly projecting ends in alignment, so as to form a circular field magnet with inwardly projecting pole pieces.

470,752. Electrical Hose Signaling Apparatus; William Fowler, of Colorado Springs, Colo. Application filed Aug. 24, 1891. In an electrical hose signaling apparatus, the combination, with the alarm mechanism, the hose sections, and the conducting wires attached thereto, of an insulating ring attached to the engaging coupling extremities of the hose section, one of the rings being provided with metallic springs to which the circuit wires lead, and the other with metal cased chambers connected with the circuit wires and spring actuated pistons having contact pins normally projecting from the outer surface of the ring, and an intermediate circumferential insulating plate provided on one face with metal contact plates adapted to engage springs respectively, and on the opposite face with separate contact rings respectively connected electrically with plates and pins when the hose sections are coupled.

470,766. Arc Light Hanger; Charles A. Pfluger, of Chicago, Ill., Assignor by direct and mesne assignments to the Standard Electric Company, of Illinois. Application filed May 15, 1891. In an arc lamp hanger, the combination of suspending hooks with two substially ring shaped lamp terminals placed in horizontal planes and adapted one to engage each hook, and thus the lamp to be placed in circuit without any special guide.

470,768. Printing Telegraph; Edward J. Silkman, of Baltimore, Md., Assignor of two-thirds to George D. Penniman and Thomas K. Worthington, of same place. Application filed April



No. 470,721.—Lightning Arrester.

16, 1891. The combination of a motor, its governor, gearing connecting them, a brake wheel, a friction brake rocking on a central pivot, its actuating magnets on opposite sides of the pivot and a circuit controlling switch actuated by the governor to regulate the speed of the motor.

470,772. Circuit Interrupting Device; Alexander Wurts, of Pittsburgh, Pa., Assignor to the Westinghouse Electric and Manufacturing Company, of same place. Application filed Nov. 25, 1891. The combination of two electrodes normally resting in contact with each other and thermostatic supports carrying the respective electrodes.

470,773. Circuit-Interrupting Device; Alexander Wurts, of Pittsburgh, Pa., Assignor to the Westinghouse Electric and Manufacturing Company, of same place. Application filed Dec. 1, 1891. An arc-rupturing device consisting of two or more electrodes of zinc, antimony or compounds thereof or other materials having a non-conducting vaporous oxide.

470,774. Apparatus for Protecting Circuits; Alexander Wurts, of Pittsburgh, Pa., Assignor to the Westinghouse Electric and Manufacturing Company, of same place. Application filed Dec. 16, 1891. The combination, with one or more electric circuits, of an earth discharging circuit having an air space interposed in its length and a contact device connecting the respective sides of the first named circuit or circuits with said discharge circuit at different times. (See illustration.)

470,784. Dynamo; William H. Elkins, of Cambridge, Mass. Application filed June 29, 1891. The method of regulating dynamos, consisting in splitting the current at the armature into two continuous currents and uniting them to form one constant current after each has passed through a portion of the field coils.

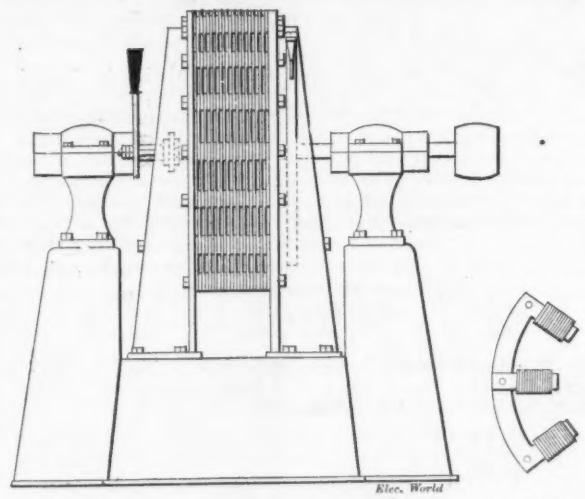
470,785. Dynamo; William H. Elkins, of Cambridge, Mass. Application filed July 11, 1891. In a constant current dynamo, two pairs of brushes of like sign, one brush of each pair connected to the corresponding brush of the other pair, by a circuit of which portions of the field coils and translating devices form a part of the other two brushes of each pair, connected to the terminals of that circuit through other portions of the field coils, the constant current at full load flowing through the main coils and a smaller current flowing through the regulating coils, and the number of turns of wire in the regulating coils being materially greater than the number of turns in the corresponding portions of the main coils.

470,786. Appointment Signal for Telephones; Silas W. Gray, of Fort Dodge, Ia. Application filed May 12, 1891. The combination with the main line of a telephone of a series of radially movable contact points, a dial and clock train, a stationary contact point, said radially movable contact points being mounted in a revoluble frame and arranged to bear a fixed relation to the figures on the clock dial, means for protruding said points consecutively into a path in operative proximity to said stationary point, and electromagnet normally in circuit with said telephone line, an armature and releasing device in operative proximity to said magnet, and means for re-engaging said releasing device and returning it to its normal position upon a single revolution of the disc bearing said radial contact points. (See illustration.)

470,790. Electric Switch; Hugh Moore and Oliver Otis Jarrard, of Mauch Chunk, Pa. Application filed Sept. 4, 1891. In an electrical switch, the base having an upwardly extending flange, and perforations therethrough, curved contact plates having perforated lugs for the reception of the binding posts or circuit wires, the plates being seated within the inner periphery on opposite sides of the flange, and having the perforated lug thereof registering with said perforations through the base and flange, notched recesses in the inner periphery of said flange, and alternately disposed with relation to said plates, a centrally perforated bar secured transversely to opposite sides of the flange, and a commutator or switch wheel revolubly mounted upon said base, and having its operating spindle working in the perforations of said bar, and its hub beneath said bar, the hub being provided with the oppositely curved series of contact brushes or plates secured therein, and adapted to travel around the inner periphery of said flange to break and close the circuit.

470,792. Galvanic Battery; Francis H. Root, of Chicago, Ill. Application filed Nov. 5, 1888. A battery comprising a cell closed at its top and provided with a vent tube, a packing of mineral fibre arranged within a cell, a chloride of silver electrode embedded within the packing, a zinc electrode surrounding the packing, and an excitant consisting of a caustic solution.

470,793. Switch for Electric Signaling Apparatus; Leopold Sellner, of Vienna, Austria-Hungary. Application filed Oct. 17, 1891. An electric switch comprising a switch plate having a series of branches extending therefrom, said branches being constructed in two parts insulated from each other by an intervening hiatus, said plate and insulated portions of its branches being respectively connected with the terminals of an electric



No. 470,928.—Alternating Current Generator.

circuit, and a switch plug interposed and having motion in the hiatus between the branch sections, said plugs having a non-conductive portion normally in contact with the branch section, whereby the electric circuit through any one or more of the branches of the switch may be closed or interrupted.

470,806. Railroad Circuit Closer; Frank E. Kinsman, of Plainfield, N. J. Application filed July 30, 1891. A railway circuit closer mounted to travel with its edge in line with the wheel flange and attached to its supporting arm by a joint or hinge adapted to permit the circuit closer to yield in the line of movement of the vehicle.

470,813. Electric Railway Signal; Adoniram J. Wilson, of Port Chester, N. Y., Assignor to the Hall Signal Company, of Maine. Application filed Nov. 9, 1891. In a block signaling apparatus, the combination, with a series of normally closed rail circuits, of a series of normally open or broken signaling circuits, each signaling circuit including a normally open circuit closer constructed to be closed by the action of the train upon one of the rail circuits and also including a normally closed circuit breaker constructed to be opened by the action of the train upon the next succeeding rail circuit of the line.

470,817. Electric Railway Motor; Francis O. Blackwell, of New York, Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed Aug. 31, 1889. The combination with a driven axle of a vehicle, of an electric motor journaled thereon, having its field coil and core arranged vertically between the armature and axle.

470,820. Electric Connector; William H. Garland, of Chelsea, Mass., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed Nov. 23, 1891. An electric connecting plug consisting of a sleeve or tube with its bore eccentric to its axis, leaving a thin and comparatively yielding wall on one side of the tube.

470,831. Annunciator; Archibald H. Brintnell, of Toronto, Can. Application filed April 11, 1891. In combination, a main battery and trouble-alarm wires, including a thermostat to throw the current off said wires, a relay in the trouble-alarm circuit, controlling a local circuit, a trouble alarm in said local circuit and a movable indicating-plate controlled by the armature of the relay to be operated simultaneously with the completing of the local circuit and the ringing of the alarm.

470,844. Electric-Wire Support; Francis O. Blackwell, of New York, Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed June 17, 1889. A holder supporting an electric railway supply wire, having lips of malleable metal bent down upon opposite sides of the wire and arranged out of line with one another.

470,865. Transmission of Electrical Energy to a Distance; Marcel Deprez and Jules Carpentier, of Paris, France, said Carpentier Assignor to said Deprez. Application filed Nov. 27, 1888. The improvement in the art of transmitting electrical energy to and utilizing it at a distance from the source, which consists in generating maintained and practically uniform currents of high tension at one station and sending the same over a line of conductors to another station, and generating maintained and practically uniform currents of lower tension at the second station by the inductive influence of the high-tension currents.

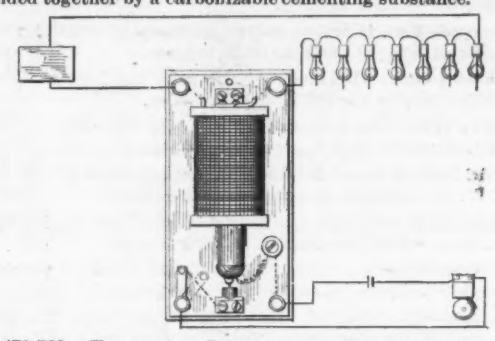
470,883. Insulation for Electric Wires; Samuel Vanstone, of Providence, R. I., Assignor to himself and Frederic A. Fairbrother, Jr., of same place. Application filed March 21, 1890. An insulating covering for electric wires, formed of abutting longitudinally divided sections of rigid non-conducting material, the abutting ends of which form a socket joint.

470,922. Manufacture of Filaments for Incandescent Lamps; Thomas A. Edison, of Menlo Park, N. J. Application filed Oct. 10, 1883. The method of forming blanks or sheets for the purpose mentioned, consisting in treating separately two or more sheets of paper with hydrofluoric acid to form a cementing material and then placing such sheets together.

470,923. Railway Signaling; Thomas A. Edison, of Llewellyn Park, N. J. Application filed Aug. 19, 1887. In a system of electrical signaling, the combination of one or more signals, each having a magnet and means controlled thereby for operating the signal by a first energization of the magnet and for changing the signal by a following energization, said magnet or magnets being included in an electric circuit, and a magnet on a moving train for inducing a current in the coils of stationary electromagnets, the coils of said stationary magnets being in said electric circuit, whereby the signal is set and then changed by the successive currents induced in the circuit.

470,924. Electric Conductor; Thomas A. Edison, of Llewellyn Park, N. J. Application filed Sept. 30, 1887. The combination of a wire, a fabric covering thereon, and an outer covering of a mixture of rubber and infusable material.

470,925. Manufacture of Filaments for Incandescent Electric Lamps; Thomas A. Edison. Application filed March 20, 1880. A filament for forming the carbon incandescing conductor of an electric lamp, consisting of a number of fine filaments, welded together by a carbonizable cementing substance.



No. 470,722.—Telltale Device for Electric Circuits.

470,926. Dynamo-Electric Machine or Motor; Thomas A. Edison. Application filed Feb. 24, 1891. A magnet pole-piece consisting of several distinct layers of iron or steel united for a part of their length into an integral mass.

470,928. Alternating Current Generator; Thomas A. Edison, Llewellyn Park, N. J. Application filed Aug. 25, 1891. In an electromagnetic machine, the field magnet having several poles and consisting of over-lapping magnetic plates bolted together so that the plates shall be in contact at the ends, but shall be separated throughout a portion of their length, said plates having main bodies and projecting legs, the latter constituting the field magnet poles. (See illustrations.)

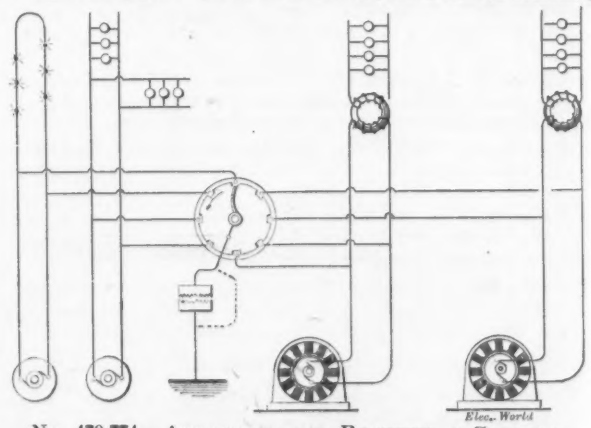
470,929. Magnetic Separator; Thomas A. Edison, of Llewellyn Park, N. J. Application filed Oct. 1, 1891. The combination of a receptacle adapted to contain fine magnetic ore and to allow escape of the same, a magnet for changing the trajectory of the magnetic particles in the ore, said magnet having two poles in position to act on the falling ore, one pole being below the other and formed by a Z-shaped arm having an end bent to form an extended pole substantially parallel with the falling magnetic material.

470,930. Dynamo-Electric Machine; Thomas A. Edison, of Llewellyn Park, N. J. Application filed Oct. 10, 1891. In a multipolar electromagnetic machine, the combination of the armature core, the armature coil covering the whole surface of said core, a commutator having a number of conducting blocks, the series of field magnets forming a succession of alternating like and unlike fields, commutator connections between all portions of the armature coils situated in corresponding magnetic fields and the same commutator blocks whereby a continuous current is produced and the commutator brushes taking the current from and delivering current to all parts of said coil.

470,942. Appliance for Sighting Guns; Ludwig Mautner von Markhof, of Vienna, Austria-Hungary. Application filed Nov. 6, 1890. The combination, with a gun carried by an oscillating support, of sighting devices comprising an adjustable sight independent of the gun, a non-conductive scale connected with the sight, a conductive index adjustable on the scale, a contact connected with the gun and adapted to move over the scale, and a normally interrupted electric firing or alarm circuit, including said index and contact.

470,946. Underground Electric Conduit; James F. Munsie, of Jersey City, N. J., Assignor to Thomas Leonard Coles, of New York. Application filed Oct. 9, 1889. An underground electric conduit system consisting of a through-wire conduit, distributing ducts extending along said conduit, and service ducts leading transversely from the distributing ducts, the through-wire conduit and distributing ducts being divided up into sections by man-holes spaced at intervals along the line and the service ducts being provided with man-holes at their ends remote from the main conduit, and devices whereby the wire may be withdrawn from the main conduit through the service ducts.

470,994. Contact Maker; Daniel Draper, of Hastings-on-Hudson, N. Y. Application filed Sept. 30, 1891. The combination of a fixed electrical contact, a spring contact making and contact magnet arranged to act on the armature, and a cam for detaching



No. 470,774.—Apparatus for Protecting Circuits.

the armature from the magnet and removing the spring arm from the electrical contact.

471,063. Electric Elevator; Rudolph C. Smith, of Yonkers, N. Y., Assignor by mesne assignments to the National Company, of Chicago, Ill. Application filed Nov. 11, 1891. The combination, with a multiple wire system of electrical distribution, of a shunt motor and means for changing the connection of said motor from one of the wires of the said system to another to vary the speed of the motor,

471,064. Electric Elevator; Rudolph C. Smith, of Yonkers, N. Y., Assignor by mesne assignments to the National Company, of Chicago, Ill. Application filed Nov. 30, 1891. In an electric elevator, the combination, with the motor and car operated thereby and a switch located on the car, of circuit connections between the field magnet coils of the motor only and the switch on the car,

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.